Reading data

In [1]:
```
import pandas as pd
```

In [113…
```
df = pd.read_csv("customer_churn.csv")
```

In [114…
```
target_column =  "Churn"
features = ['Call  Failure', 'Complains', 'Subscription  Length', 'Charge  Amount',
       'Seconds of Use', 'Frequency of use', 'Frequency of SMS',
       'Distinct Called Numbers', 'Age Group', 'Tariff Plan', 'Status', 'Age',
       'Customer Value']
```

In [115…
```
df.head()
```

Out[115…

	Call Failure	Complains	Subscription Length	Charge Amount	Seconds of Use	Frequency of use	Frequency of SMS	Distinct Called Numbers
0	8	0	38	0	4370	71	5	17
1	0	0	39	0	318	5	7	4
2	10	0	37	0	2453	60	359	24
3	10	0	38	0	4198	66	1	35
4	3	0	38	0	2393	58	2	33

Data visualization

In [116…
```
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import plotly.graph_objects as go
from plotly.subplots import make_subplots
import warnings
warnings.filterwarnings('ignore')
```

In [117…
```
feature = "Status"
a = df[feature].value_counts()
a.index.tolist()
```

Out[117…
```
[1, 2]
```

In [118…
```
churn_labels = ['No', 'Yes']
fig = make_subplots(rows=2, cols=2, specs=[[{'type':'domain'}, {'type':'domain'}],
fig.add_trace(go.Pie(labels=churn_labels, values=df['Churn'].value_counts(), name="
```

```
def add_trace(feature, row, col):
    values = df[feature].value_counts()
    labels = values.index.tolist()
    fig.add_trace(go.Pie(labels=labels, values=values, name=feature), row, col)
add_trace("Status", 1, 2)
add_trace("Age Group", 2, 1)
add_trace("Tariff Plan", 2, 2)


fig.update_traces(hole=.4, hoverinfo="label+percent+name", textfont_size=16)

fig.update_layout(
    title_text="Feature Distributions",
    annotations=[dict(text="Churn", x=0.2, y=0.84, font_size=12, showarrow=False),
                 dict(text="Status", x=0.82, y=0.84, font_size=12, showarrow=False)
                 dict(text="Age", x=0.2, y=0.195, font_size=12, showarrow=False),
                 dict(text="Group", x=0.2, y=0.15, font_size=12, showarrow=False),
                 dict(text="Tariff", x=0.81, y=0.195, font_size=12, showarrow=False
                 dict(text="Plan", x=0.8, y=0.145, font_size=12, showarrow=False)])
fig.show()
```

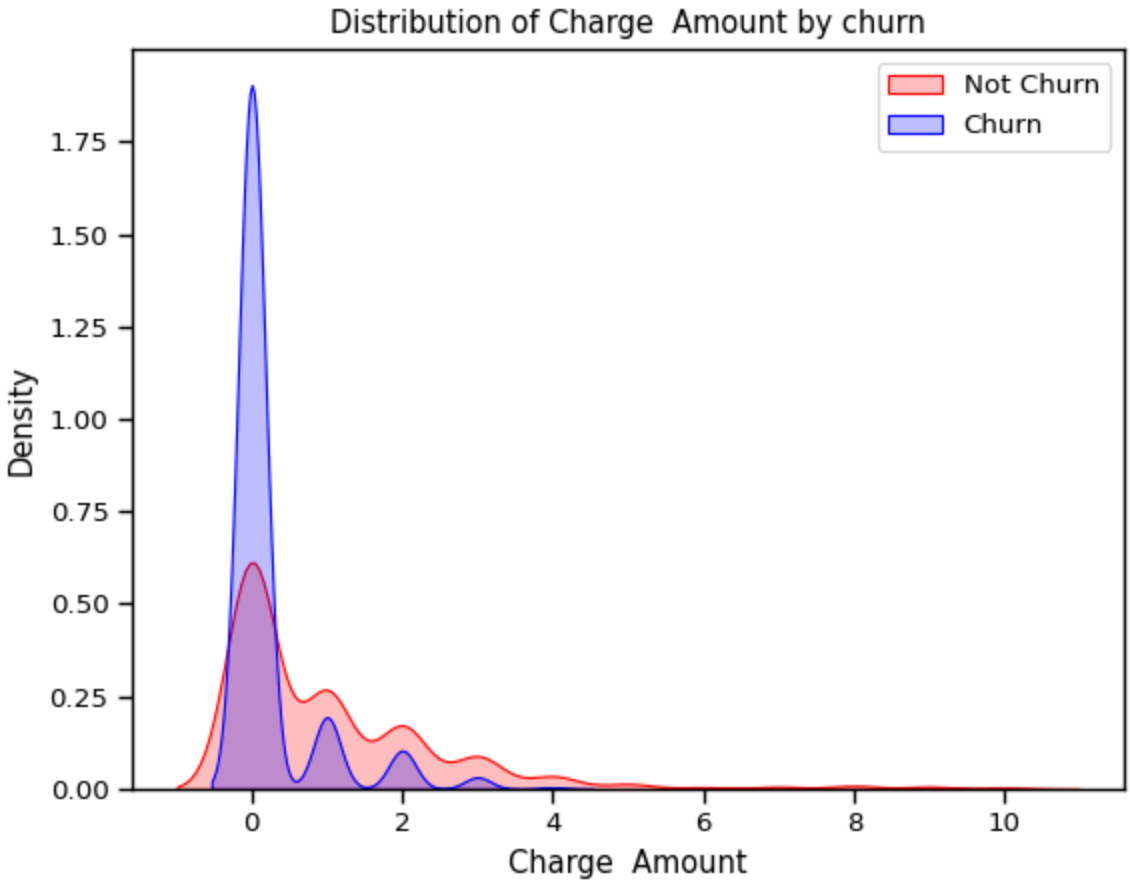
In [119…

```
def create_histogram(feature):
    fig = px.histogram(df, x="Churn", color=feature, barmode="group", title=f"<b>{f
```

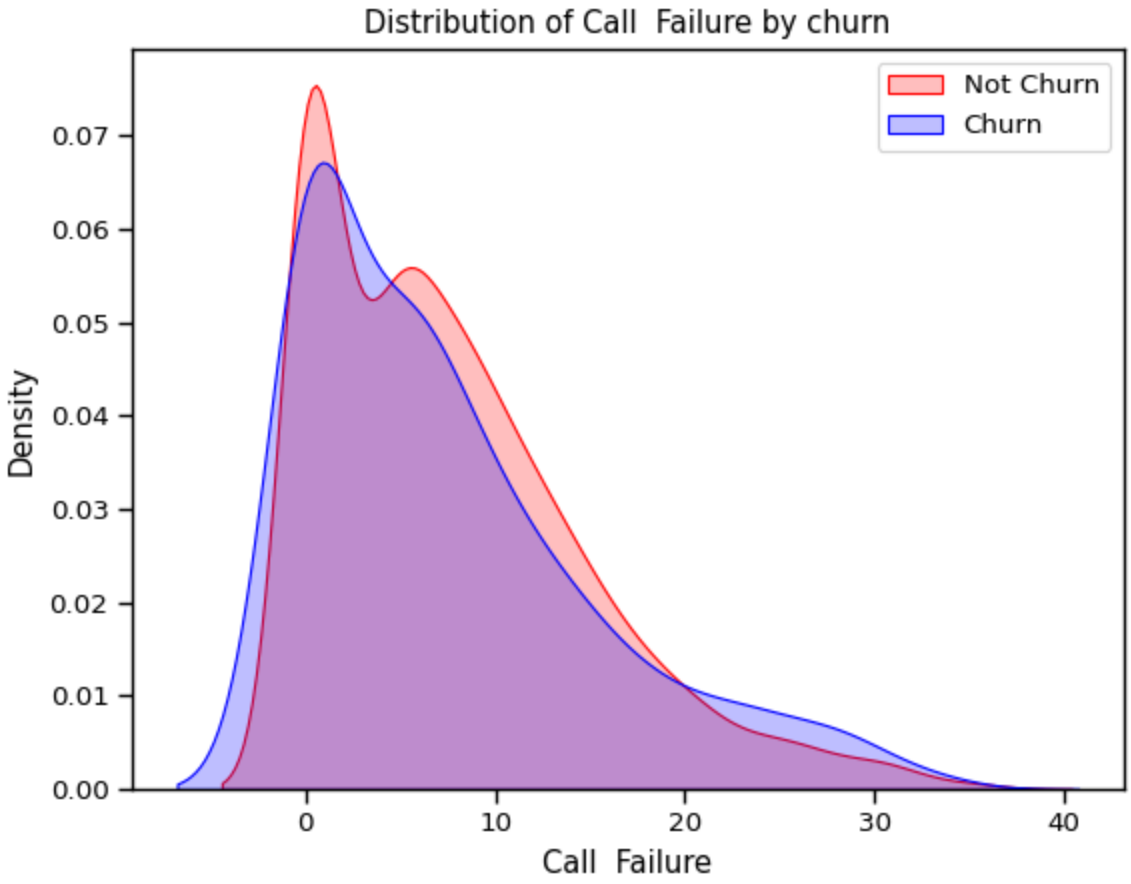
```
    fig.update_layout(width=700, height=500, bargap=0.1)
    fig.show()
create_histogram("Complains")
```

In [120…

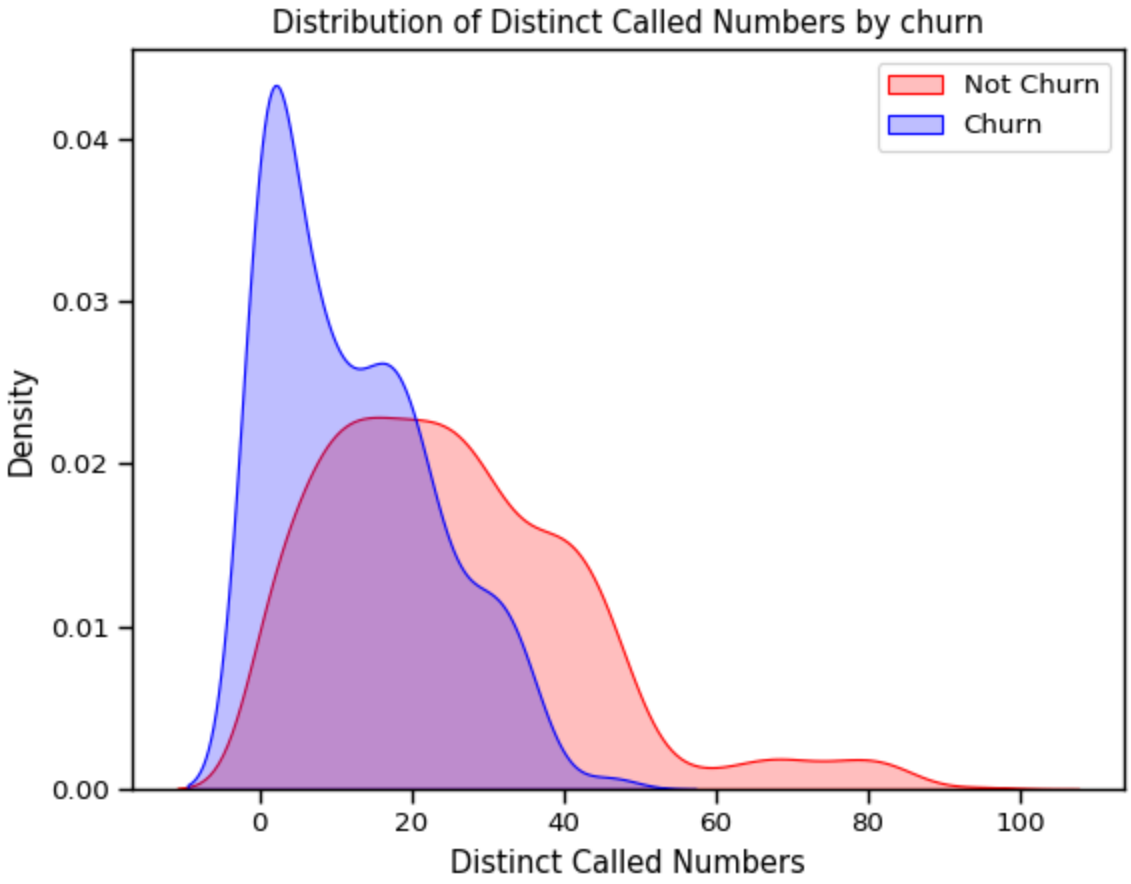
```
feature = 'Charge  Amount'
def continuous_plot(feature):
    sns.set_context("paper",font_scale=1.1)
    ax = sns.kdeplot(df[feature][(df["Churn"] == 0) ],
                     color="Red", shade = True);
    ax = sns.kdeplot(df[feature][(df["Churn"] == 1) ],
                     ax =ax, color="Blue", shade= True);
    ax.legend(["Not Churn","Churn"],loc='upper right');
    ax.set_ylabel("Density");
    ax.set_xlabel(feature);
    ax.set_title(f'Distribution of {feature} by churn');
continuous_plot('Charge  Amount')
```



In [121…
```
continuous_plot('Call  Failure')
```

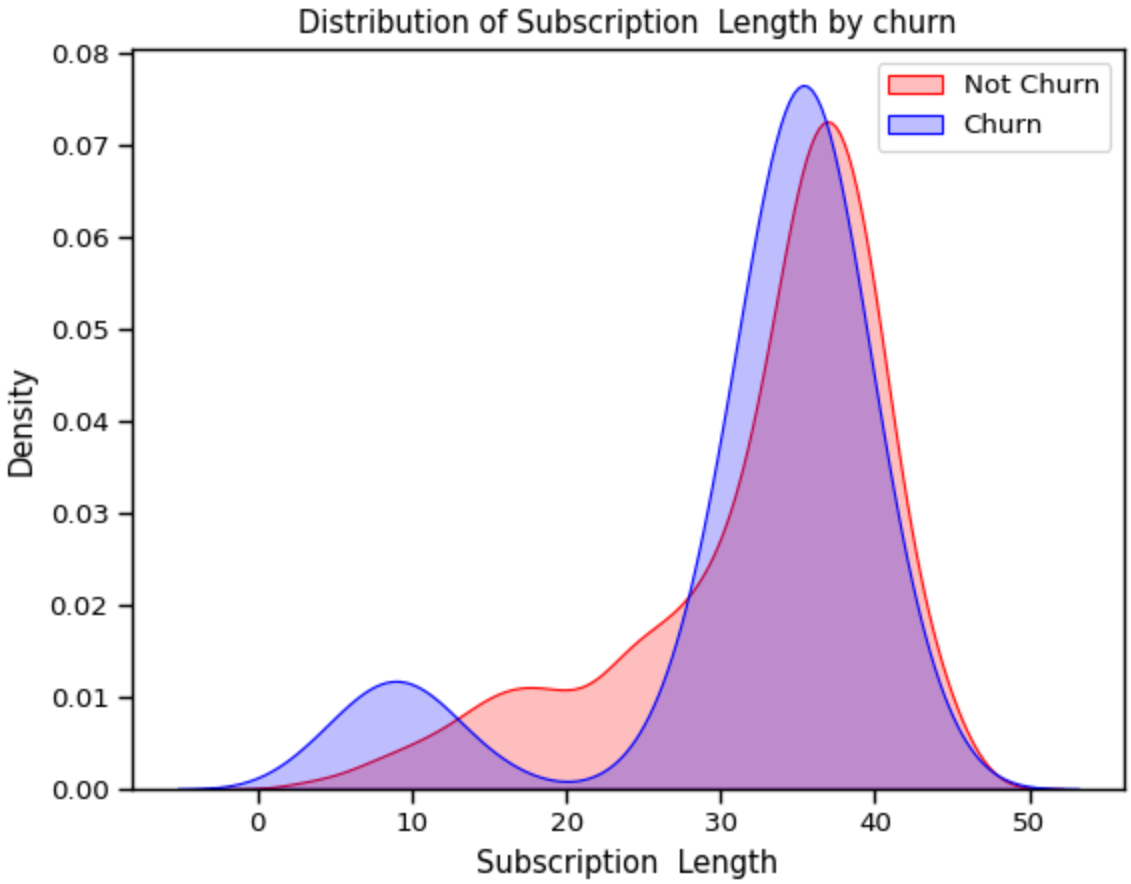


In [122…
```
continuous_plot('Distinct Called Numbers')
```

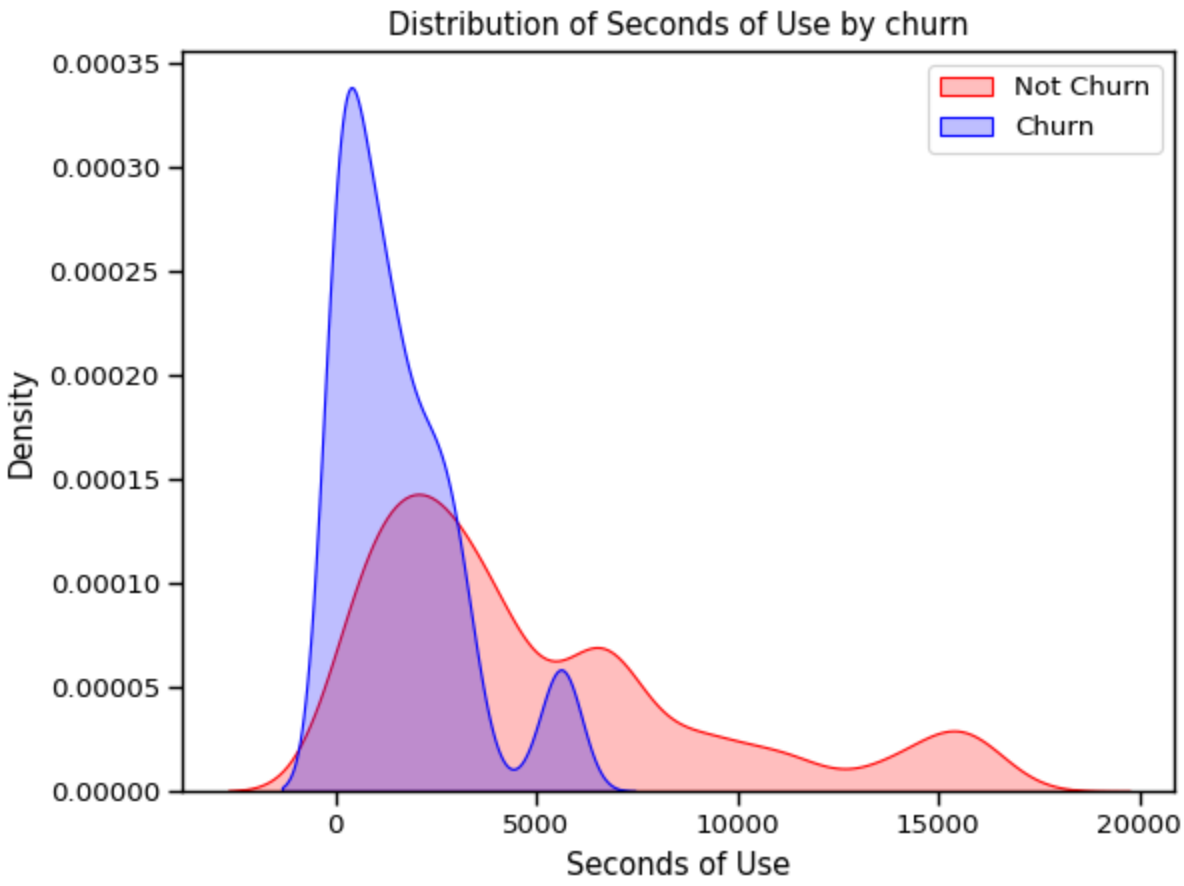


In [123…

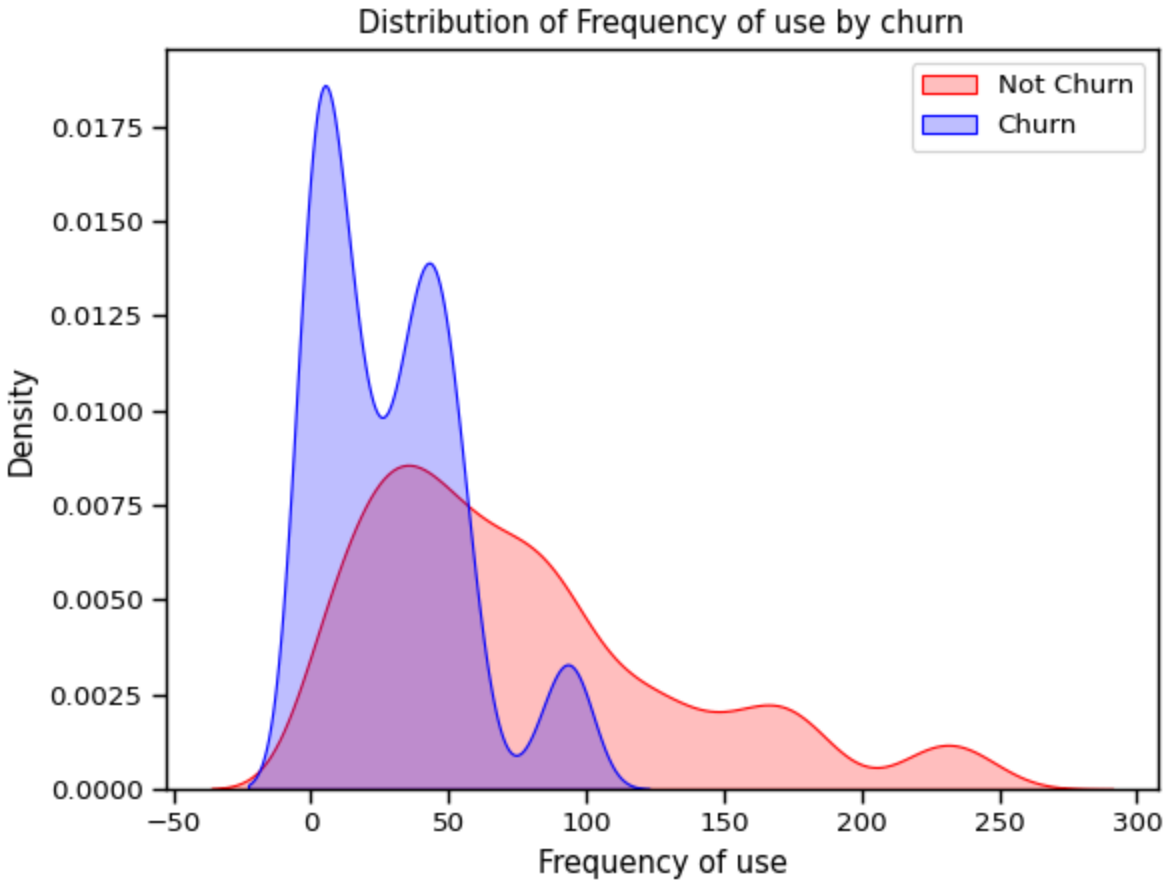
```
continuous_plot('Subscription  Length')
```



In [124…
```
continuous_plot('Seconds of Use')
```

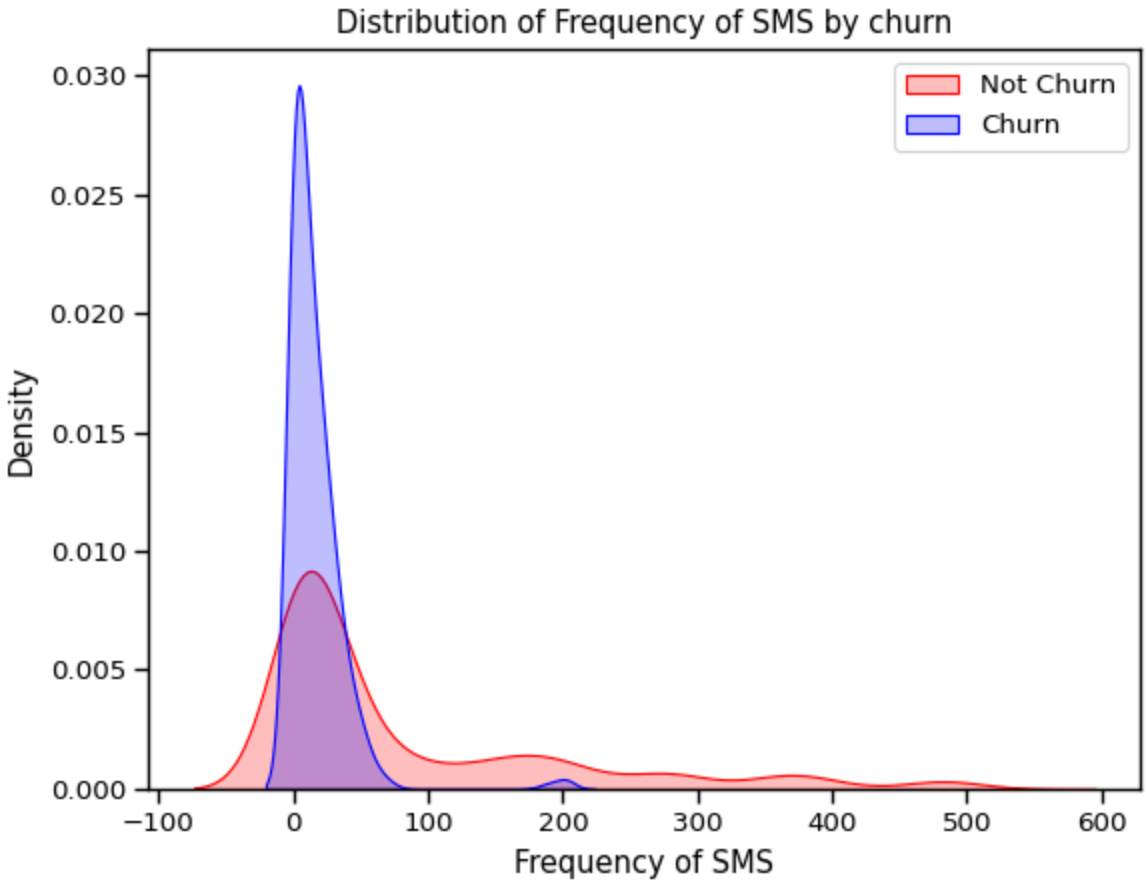


In [125…
```
continuous_plot('Frequency of use')
```

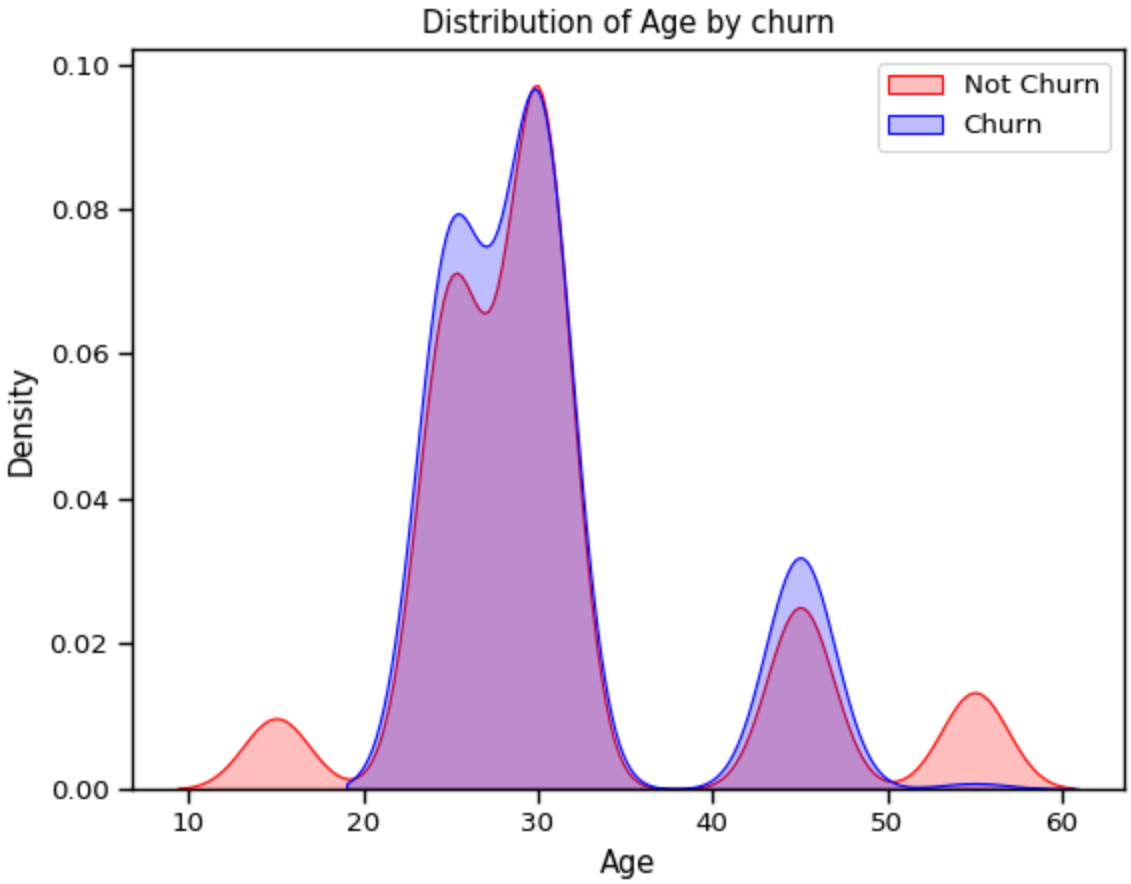


In [126…

```
continuous_plot('Frequency of SMS')
```

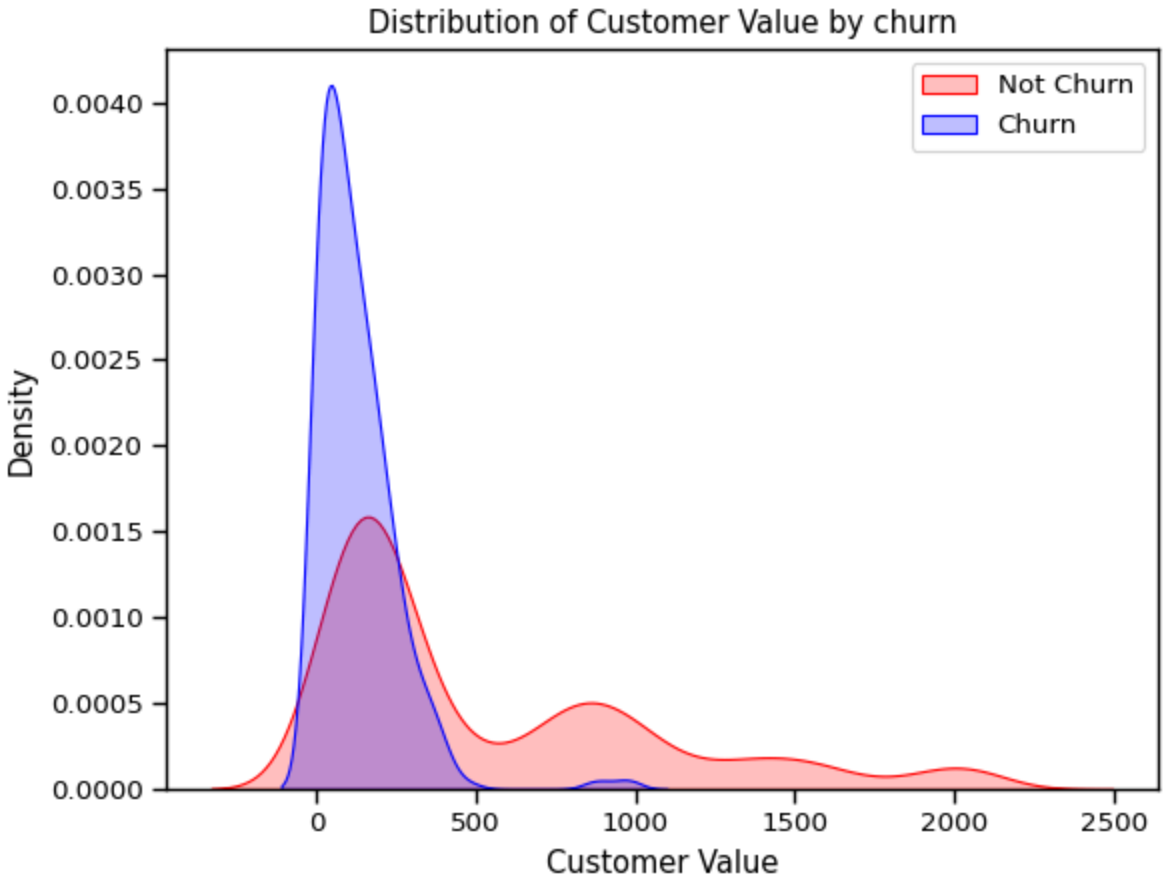


In [127…
```
continuous_plot('Age')
```



In [128…

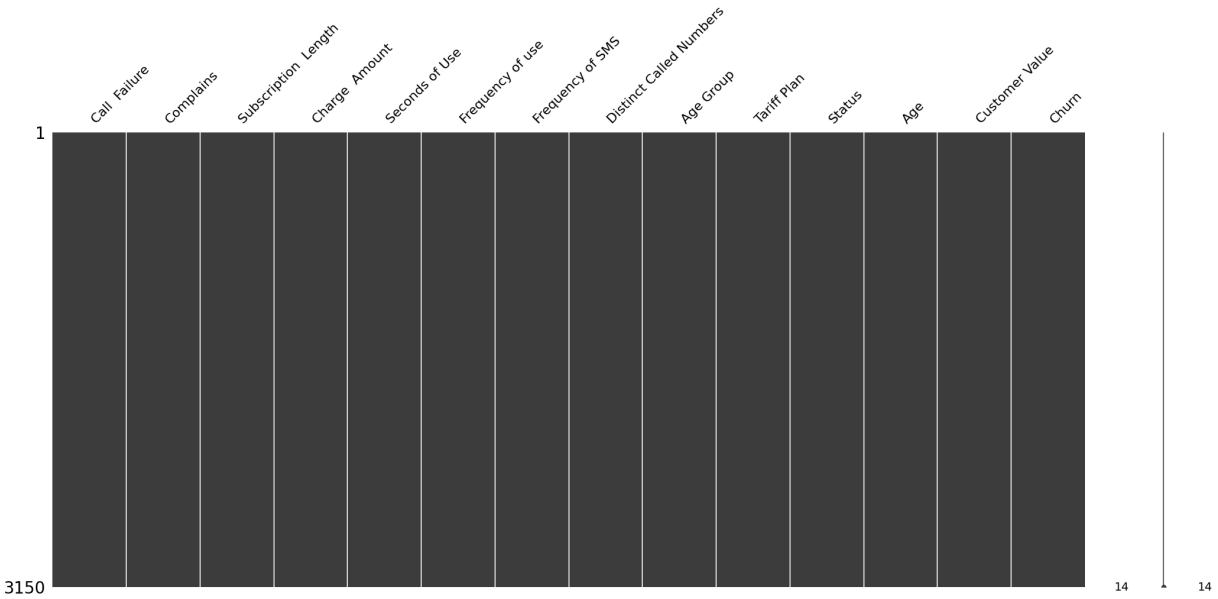
```
continuous_plot('Customer Value')
```



Data Cleaning

In [129…
```
import missingno as msno
```

In [130…
```
msno.matrix(df);
```



Data preprocessing

In [133…
```
for feat in features:
    df[feat] = pd.to_numeric(df[feat], errors='coerce')
```

In [134…
```
df.isnull().sum()
```

Out[134…
```
Call  Failure              0
Complains                  0
Subscription  Length       0
Charge  Amount             0
Seconds of Use             0
Frequency of use           0
Frequency of SMS           0
Distinct Called Numbers    0
Age Group                  0
Tariff Plan                0
Status                     0
Age                        0
Customer Value             0
Churn                      0
dtype: int64
```

In [136…
```
df.describe()
```

Out[136…

	Call Failure	Complains	Subscription Length	Charge Amount	Seconds of Use	Frequency of use	F
count	3150.000000	3150.000000	3150.000000	3150.000000	3150.000000	3150.000000	315
mean	7.627937	0.076508	32.541905	0.942857	4472.459683	69.460635	7
std	7.263886	0.265851	8.573482	1.521072	4197.908687	57.413308	1
min	0.000000	0.000000	3.000000	0.000000	0.000000	0.000000	
25%	1.000000	0.000000	30.000000	0.000000	1391.250000	27.000000	
50%	6.000000	0.000000	35.000000	0.000000	2990.000000	54.000000	2
75%	12.000000	0.000000	38.000000	1.000000	6478.250000	95.000000	8
max	36.000000	1.000000	47.000000	10.000000	17090.000000	255.000000	52

Test Train split

In [143…
```
from sklearn.model_selection import train_test_split
X = df[features]
y = df[target_column]
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25, random_st
```

Standardizing numerical values

In [144…
```
from sklearn.preprocessing import StandardScaler
num_cols = ["Customer Value"]
scaler= StandardScaler()

X_train[num_cols] = scaler.fit_transform(X_train[num_cols])
X_test[num_cols] = scaler.transform(X_test[num_cols])
```

Modeling

In [163…
```
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import recall_score, confusion_matrix, precision_score, f1_sco
```

In [147…
```
from sklearn.model_selection import GridSearchCV
```

In [152…
```

```

Out[152…
```
[0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]
```

In [157…
```
models = {
        "Logistic Regression": {
            "model": LogisticRegression(),
            "params": {
                "solver": ['lbfgs', 'liblinear', 'newton-cg', 'newton-cholesky', 's
                "multi_class": ['auto', 'ovr', 'multinomial'],
                "l1_ratio": [i/10 for i in range(0, 11, 1)],
                "penalty": ['l1', 'l2', 'elasticnet']
            }
        },
        "Decision Tree": {
            "model": DecisionTreeClassifier(),
            "params": {
                'criterion':['gini','entropy'],
                'max_depth':[4,5,6,7,8,9,10,11,12,15,20,30,40,50,70,90,120,150]
            }
        }
    }
```

In [158…
```
for model in models:
    print(f"Fitting {model}")
    model_handle = models[model]["model"]
    model_params = models[model]["params"]
    gcv = GridSearchCV(model_handle, models[model]["params"], cv=5, verbose = 1, n_
```

```
    models[model]["result"] = {
        "score": gcv.best_score_*100,
        "estimator": gcv.best_estimator_,
        "params": gcv.best_params_
    }
```

```
Fitting Logistic Regression
Fitting 5 folds for each of 594 candidates, totalling 2970 fits
Fitting Decision Tree
Fitting 5 folds for each of 36 candidates, totalling 180 fits
```

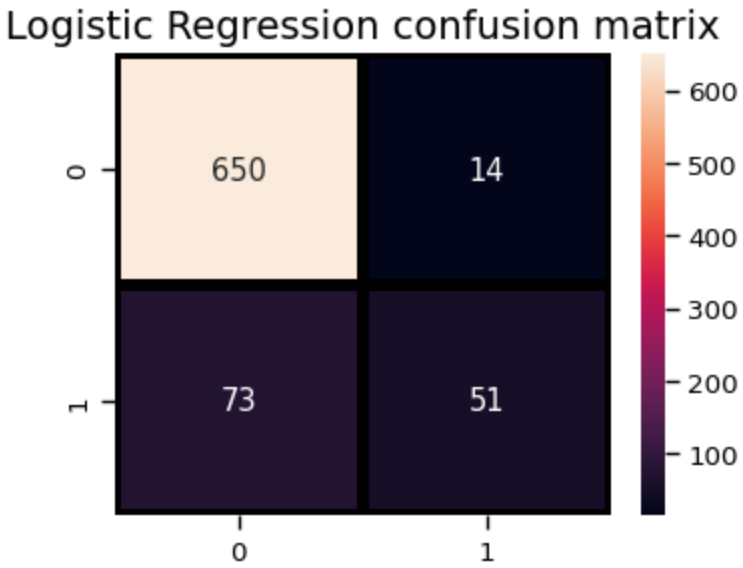
In [169…
```
models["Logistic Regression"]["result"]["params"]
```

Out[169…
```
{'l1_ratio': 0.0,
 'multi_class': 'auto',
 'penalty': 'l1',
 'solver': 'liblinear'}
```

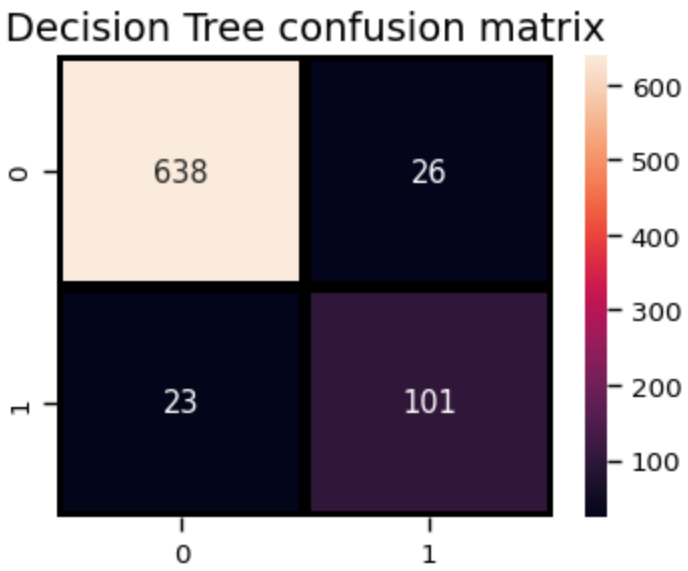
In [170…
```
models["Decision Tree"]["result"]["params"]
```

Out[170…
```
{'criterion': 'gini', 'max_depth': 20}
```

In [171…
```
for model_name in models:
    model = models[model_name]["result"]["estimator"]

    # Classification report
    pred = model.predict(X_test)
    report = classification_report(y_test, pred)
    plt.figure(figsize=(4,3))
    sns.heatmap(confusion_matrix(y_test, pred),
                annot=True,fmt = "d",linecolor="k",linewidths=3)

    plt.title(f"{model_name} confusion matrix",fontsize=14)
    plt.show()

    # Accuracy
    print("Accuracy: ", accuracy_score(y_test, pred)*100, "%")
```




```
Accuracy:  88.95939086294416 %
```




```
Accuracy:  93.78172588832487 %
```

In [ ]:

In [ ]:

In [ ]: