```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import plotly.express as px
import missingno as msno

import plotly.offline as py
py.init_notebook_mode(connected=True)


import warnings
warnings.filterwarnings('ignore')


from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler,LabelEncoder
```

Dataset Describe

```
import pandas as pd

# Load the dataset to understand its structure and content
file_path = 'churn.csv'
data = pd.read_csv(file_path)

# Displaying the first few rows of the dataset
data.head()
```

	customer_id	credit_score	country	gender	age	tenure	balance	products_number	credit_card	active_member	estimated_salary	chu
0	15634602	619	France	Female	42	2	0.00	1	1	1	101348.88	
1	15647311	608	Spain	Female	41	1	83807.86	1	0	1	112542.58	
2	15619304	502	France	Female	42	8	159660.80	3	1	0	113931.57	
3	15701354	699	France	Female	39	1	0.00	2	0	0	93826.63	
4	15737888	850	Spain	Female	43	2	125510.82	1	1	1	79084.10	

```
data.describe().transpose()
```

	count	mean	std	min	25%	50%	75%	max
customer_id	10000.0	1.569094e+07	71936.186123	15565701.00	15628528.25	1.569074e+07	1.575323e+07	15815690.00
credit_score	10000.0	6.505288e+02	96.653299	350.00	584.00	6.520000e+02	7.180000e+02	850.00
age	10000.0	3.892180e+01	10.487806	18.00	32.00	3.700000e+01	4.400000e+01	92.00
tenure	10000.0	5.012800e+00	2.892174	0.00	3.00	5.000000e+00	7.000000e+00	10.00
balance	10000.0	7.648589e+04	62397.405202	0.00	0.00	9.719854e+04	1.276442e+05	250898.09
products_number	10000.0	1.530200e+00	0.581654	1.00	1.00	1.000000e+00	2.000000e+00	4.00
credit_card	10000.0	7.055000e-01	0.455840	0.00	0.00	1.000000e+00	1.000000e+00	1.00
active_member	10000.0	5.151000e-01	0.499797	0.00	0.00	1.000000e+00	1.000000e+00	1.00
estimated_salary	10000.0	1.000902e+05	57510.492818	11.58	51002.11	1.001939e+05	1.493882e+05	199992.48
churn	10000.0	2.037000e-01	0.402769	0.00	0.00	0.000000e+00	0.000000e+00	1.00

handling missing values

```
# Descriptive statistical analysis
descriptive_stats = data.describe()

# Checking for missing values
missing_values = data.isnull().sum()

descriptive_stats, missing_values
```

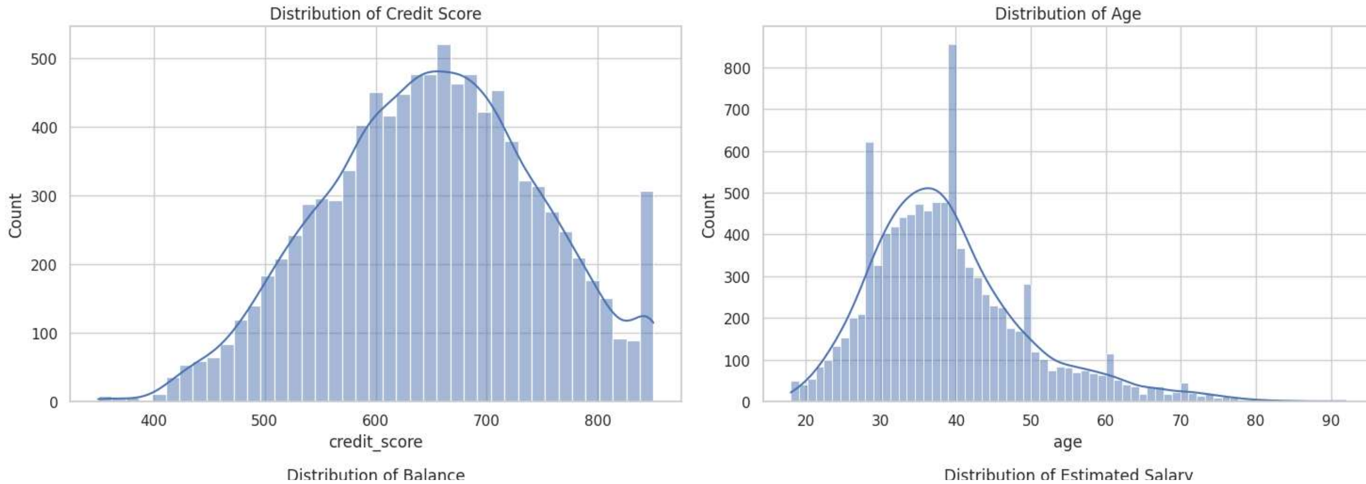
```
(        customer_id  credit_score           age        tenure        balance  \
 count  1.000000e+04  10000.000000  10000.000000  10000.000000   10000.000000
 mean   1.569094e+07    650.528800     38.921800      5.012800   76485.889288
 std    7.193619e+04     96.653299     10.487806      2.892174   62397.405202
 min    1.556570e+07    350.000000     18.000000      0.000000       0.000000
 25%    1.562853e+07    584.000000     32.000000      3.000000       0.000000
 50%    1.569074e+07    652.000000     37.000000      5.000000   97198.540000
 75%    1.575323e+07    718.000000     44.000000      7.000000  127644.240000
 max    1.581569e+07    850.000000     92.000000     10.000000  250898.090000

        products_number  credit_card  active_member  estimated_salary  \
 count     10000.000000  10000.00000   10000.000000      10000.000000
 mean          1.530200      0.70550       0.515100     100090.239881
 std           0.581654      0.45584       0.499797      57510.492818
 min           1.000000      0.00000       0.000000         11.580000
 25%           1.000000      0.00000       0.000000      51002.110000
 50%           1.000000      1.00000       1.000000     100193.915000
 75%           2.000000      1.00000       1.000000     149388.247500
 max           4.000000      1.00000       1.000000     199992.480000

               churn
 count  10000.000000
 mean       0.203700
 std        0.402769
 min        0.000000
 25%        0.000000
 50%        0.000000
 75%        0.000000
 max        1.000000  ,
 customer_id         0
 credit_score        0
 country             0
 gender              0
 age                 0
 tenure              0
 balance             0
 products_number     0
 credit_card         0
 active_member       0
 estimated_salary    0
 churn               0
 dtype: int64)
```

EDA

```
data.describe().T.sort_values(ascending = 0,by = "mean").style.background_gradient(cmap = "BuGn")\
.bar(subset = ["std"], color ="red").bar(subset = ["mean"], color ="blue")
```

	count	mean	std	min	25%	50%	75%	
customer_id	10000.000000	15690940.569400	71936.186123	15565701.000000	15628528.250000	15690738.000000	15753233.750000	15815690
estimated_salary	10000.000000	100090.239881	57510.492818	11.580000	51002.110000	100193.915000	149388.247500	199992
balance	10000.000000	76485.889288	62397.405202	0.000000	0.000000	97198.540000	127644.240000	250898
credit_score	10000.000000	650.528800	96.653299	350.000000	584.000000	652.000000	718.000000	850
age	10000.000000	38.921800	10.487806	18.000000	32.000000	37.000000	44.000000	92
tenure	10000.000000	5.012800	2.892174	0.000000	3.000000	5.000000	7.000000	10
products_number	10000.000000	1.530200	0.581654	1.000000	1.000000	1.000000	2.000000	4
credit_card	10000.000000	0.705500	0.455840	0.000000	0.000000	1.000000	1.000000	1
active_member	10000.000000	0.515100	0.499797	0.000000	0.000000	1.000000	1.000000	1
churn	10000.000000	0.203700	0.402769	0.000000	0.000000	0.000000	0.000000	1

```
import matplotlib.pyplot as plt
import seaborn as sns

# Setting the aesthetic style of the plots
sns.set(style="whitegrid")

# Creating a figure with multiple subplots
fig, axes = plt.subplots(nrows=2, ncols=2, figsize=(15, 10))

# Plotting distributions of key variables
sns.histplot(data['credit_score'], kde=True, ax=axes[0, 0])
axes[0, 0].set_title('Distribution of Credit Score')

sns.histplot(data['age'], kde=True, ax=axes[0, 1])
axes[0, 1].set_title('Distribution of Age')

sns.histplot(data['balance'], kde=True, ax=axes[1, 0])
axes[1, 0].set_title('Distribution of Balance')

sns.histplot(data['estimated_salary'], kde=True, ax=axes[1, 1])
axes[1, 1].set_title('Distribution of Estimated Salary')

plt.tight_layout()
plt.show()

# Creating boxplots to identify outliers
fig, axes = plt.subplots(nrows=2, ncols=2, figsize=(15, 10))

sns.boxplot(x='credit_score', data=data, ax=axes[0, 0])
axes[0, 0].set_title('Boxplot of Credit Score')

sns.boxplot(x='age', data=data, ax=axes[0, 1])
axes[0, 1].set_title('Boxplot of Age')

sns.boxplot(x='balance', data=data, ax=axes[1, 0])
axes[1, 0].set_title('Boxplot of Balance')

sns.boxplot(x='estimated_salary', data=data, ax=axes[1, 1])
axes[1, 1].set_title('Boxplot of Estimated Salary')

plt.tight_layout()
plt.show()
```




```
fig = px.histogram(data, x="age", y="balance", color="churn", marginal="box",hover_data=data.columns)
fig.show()
```



```
def plot_correlation_heatmap(data):
    numeric_data = data.select_dtypes(include=[np.number])
    plt.figure(figsize=(10, 8))
    sns.heatmap(numeric_data.corr(), annot=True, cmap='coolwarm')
    plt.title('Correlation Heatmap')
    plt.show()
```

```
def plot_categorical_churn(data):
    fig, axes = plt.subplots(nrows=2, ncols=2, figsize=(15, 10))

    sns.countplot(x='country', hue='churn', data=data, ax=axes[0, 0])
    axes[0, 0].set_title('Churn by Country')

    sns.countplot(x='gender', hue='churn', data=data, ax=axes[0, 1])
    axes[0, 1].set_title('Churn by Gender')

    sns.countplot(x='products_number', hue='churn', data=data, ax=axes[1, 0])
    axes[1, 0].set_title('Churn by Number of Products')

    sns.countplot(x='credit_card', hue='churn', data=data, ax=axes[1, 1])
    axes[1, 1].set_title('Churn by Credit Card Possession')

    plt.tight_layout()
    plt.show()



def plot_numerical_scatter(data):
    fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(15, 5))

    sns.scatterplot(x='age', y='balance', hue='churn', data=data, ax=axes[0])
    axes[0].set_title('Age vs. Balance')

    sns.scatterplot(x='credit_score', y='estimated_salary', hue='churn', data=data, ax=axes[1])
    axes[1].set_title('Credit Score vs. Estimated Salary')

    plt.tight_layout()
    plt.show()



def plot_churn_distribution(data):
    churn_counts = [data[data['churn'] == 1].shape[0], data[data['churn'] == 0].shape[0]]
    churn_labels = ['Churned Customers', 'Retained Customers']
    fig, ax = plt.subplots(figsize=(10, 8))
    ax.pie(churn_counts, labels=churn_labels, shadow=True, autopct='%1.2f%%')
    plt.legend()
    plt.title("Comparison of Churned and Retained Customers", size=15)
    plt.show()



def display_grouped_statistics(data):
    numeric_columns = data.select_dtypes(include=[np.number]).columns
    feature_columns = numeric_columns.drop('churn') if 'churn' in numeric_columns else numeric_columns
    grouped_mean = data.groupby('churn')[feature_columns].mean().style.background_gradient(cmap="cool")
    grouped_median = data.groupby('churn')[feature_columns].median().style.background_gradient(cmap="cool")
    return grouped_mean, grouped_median



plot_correlation_heatmap(data)
plot_categorical_churn(data)
plot_numerical_scatter(data)
```


```
plot_churn_distribution(data)
mean_display, median_display = display_grouped_statistics(data)
mean_display
```


```
median_display
```

churn	customer_id	credit_score	age	tenure	balance	products_number	credit_card	active_member	estimated_salary
0	15691543.000000	653.000000	36.000000	5.000000	92072.680000	2.000000	1.000000	1.000000	99645.040000
1	15688963.000000	646.000000	45.000000	5.000000	109349.290000	1.000000	1.000000	0.000000	102460.840000

```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import ColumnTransformer
from sklearn.pipeline import Pipeline
from sklearn.impute import SimpleImputer

# Defining the features and target variable
features = data.drop(['churn', 'customer_id'], axis=1)  # Dropping 'customer_id' as it's not useful for prediction
target = data['churn']

# Identifying categorical and numeric columns
categorical_cols = features.select_dtypes(include=['object', 'category']).columns
numeric_cols = features.select_dtypes(include=['int64', 'float64']).columns

# Creating transformers for numeric and categorical columns
numeric_transformer = Pipeline(steps=[
    ('imputer', SimpleImputer(strategy='median')),  # Imputing missing values if any
    ('scaler', StandardScaler())])  # Scaling numeric features

categorical_transformer = Pipeline(steps=[
    ('imputer', SimpleImputer(strategy='constant', fill_value='missing')),  # Imputing missing values if any
    ('onehot', OneHotEncoder(handle_unknown='ignore'))])  # One-hot encoding for categorical variables

# Combining transformers into a ColumnTransformer
preprocessor = ColumnTransformer(
    transformers=[
        ('num', numeric_transformer, numeric_cols),
        ('cat', categorical_transformer, categorical_cols)])

# Splitting the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(features, target, test_size=0.2, random_state=42)

# Applying the transformations to the training data
X_train = preprocessor.fit_transform(X_train)
X_test = preprocessor.transform(X_test)

X_train.shape, X_test.shape, y_train.shape, y_test.shape
```

```
((8000, 13), (2000, 13), (8000,), (2000,))
```

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

# Initializing the Logistic Regression model
logistic_model = LogisticRegression(random_state=42)

# Training the model
logistic_model.fit(X_train, y_train)

# Predicting on the test set
y_pred = logistic_model.predict(X_test)

# Calculating accuracy and other metrics
accuracy = accuracy_score(y_test, y_pred)
conf_matrix = confusion_matrix(y_test, y_pred)
class_report = classification_report(y_test, y_pred)

print(accuracy)
```

```
0.811
```

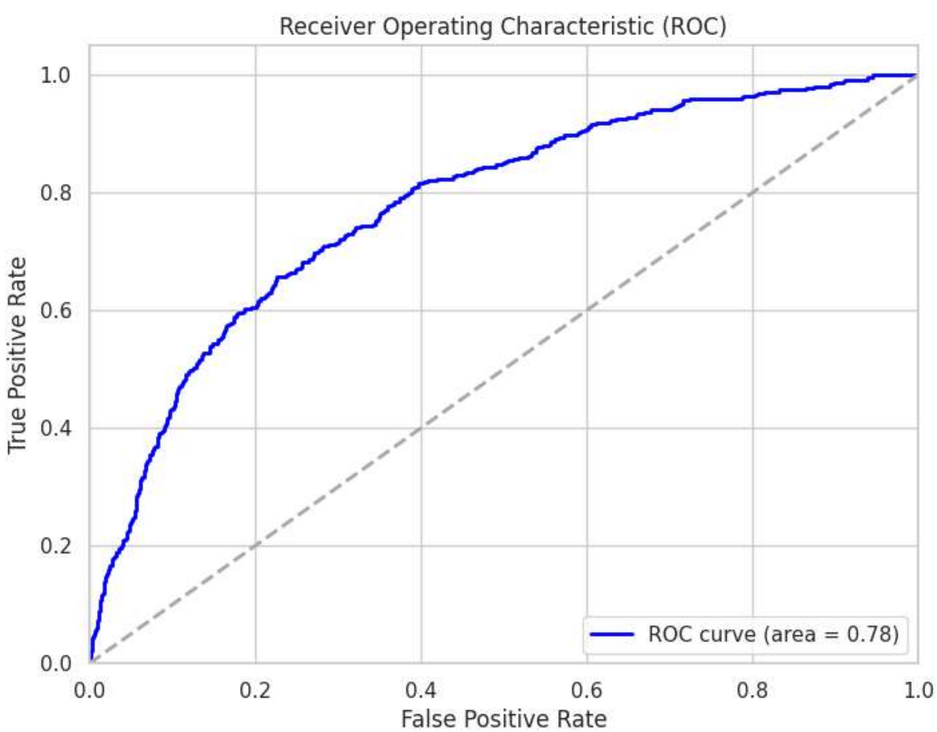
```
conf_matrix
```

```
array([[1543,   64],
       [ 314,   79]])
```

```
print(class_report)
```

```
              precision    recall  f1-score   support

           0       0.83      0.96      0.89      1607
           1       0.55      0.20      0.29       393

    accuracy                           0.81      2000
   macro avg       0.69      0.58      0.59      2000
weighted avg       0.78      0.81      0.77      2000
```

```
from sklearn.metrics import roc_curve, auc

# Calculating the probabilities of the predictions
y_prob = logistic_model.predict_proba(X_test)[:, 1]

# Generating ROC curve values: fpr, tpr, thresholds
fpr, tpr, thresholds = roc_curve(y_test, y_prob)

# Calculating AUC
roc_auc = auc(fpr, tpr)

# Plotting ROC Curve
plt.figure(figsize=(8, 6))
plt.plot(fpr, tpr, color='blue', lw=2, label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='darkgray', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC)')
plt.legend(loc="lower right")
plt.show()

roc_auc
```




```
0.7788792987423027
```