```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import sklearn
from sklearn.preprocessing import StandardScaler
```

```
sheet_names = pd.ExcelFile('E:\DATA\quantinum forage\LLOYDS BANKING
GROUP ANALYSIS\Customer_Churn_Data_Large.xlsx').sheet_names
```

```
dfs = [ pd.read_excel('E:\DATA\quantinum forage\LLOYDS BANKING GROUP
ANALYSIS\Customer_Churn_Data_Large.xlsx', sheet_name=sheet) for sheet
in sheet_names ]
```

```
df_cd = dfs[0]
df_th = dfs[1]
df_cs = dfs[2]
df_oa = dfs[3]
df_churn = dfs[4]
```

```
df_cd
```

{"columns":[{"name":"index","rawType":"int64","type":"integer"},
{"name":"CustomerID","rawType":"int64","type":"integer"},
{"name":"Age","rawType":"int64","type":"integer"},
{"name":"Gender","rawType":"object","type":"string"},
{"name":"MaritalStatus","rawType":"object","type":"string"},
{"name":"IncomeLevel","rawType":"object","type":"string"}],"ref":"a6a5
8328-fcea-4950-9ac6-034784a2802d","rows":
[["0","1","62","M","Single","Low"],["1","2","65","M","Married","Low"],
["2","3","18","M","Single","Low"],["3","4","21","M","Widowed","Low"],
["4","5","21","M","Divorced","Medium"],
["5","6","57","F","Divorced","Medium"],
["6","7","27","F","Married","High"],["7","8","37","M","Single","Low"],
["8","9","39","M","Divorced","High"],
["9","10","68","M","Married","High"],
["10","11","54","M","Divorced","Medium"],
["11","12","41","F","Married","Low"],
["12","13","24","F","Divorced","Low"],
["13","14","42","M","Widowed","Medium"],
["14","15","42","M","Divorced","Medium"],
["15","16","30","F","Single","Medium"],
["16","17","19","M","Married","Low"],
["17","18","56","F","Married","High"],
["18","19","57","F","Divorced","High"],
["19","20","41","M","Single","Low"],
["20","21","64","M","Divorced","High"],
["21","22","42","F","Divorced","Low"],
["22","23","35","F","Divorced","Low"],
["23","24","55","M","Widowed","Medium"],

["24","25","43","F","Married","Low"],
["25","26","31","M","Single","Medium"],
["26","27","26","M","Widowed","Medium"],
["27","28","27","F","Widowed","High"],
["28","29","38","F","Divorced","Medium"],
["29","30","69","M","Divorced","High"],
["30","31","34","M","Divorced","Low"],
["31","32","69","F","Married","High"],
["32","33","23","M","Divorced","High"],
["33","34","33","M","Widowed","High"],
["34","35","65","M","Married","Low"],
["35","36","18","F","Widowed","Low"],
["36","37","36","F","Married","Medium"],
["37","38","53","F","Married","Low"],
["38","39","42","M","Married","Medium"],
["39","40","67","F","Widowed","Low"],
["40","41","69","F","Married","High"],
["41","42","47","M","Widowed","Medium"],
["42","43","37","M","Single","Low"],
["43","44","37","F","Widowed","Low"],
["44","45","32","F","Widowed","Low"],
["45","46","57","F","Married","High"],
["46","47","50","F","Married","Medium"],
["47","48","19","M","Divorced","Medium"],
["48","49","27","F","Single","Medium"],
["49","50","50","F","Single","Low"]],"shape":
{"columns":5,"rows":1000}}

```
print( df_churn.shape )
print( df_cd.shape )
print( df_cs.shape )
print( df_oa.shape )
print( df_th.shape )
```

```
(1000, 2)
(1000, 5)
(1002, 5)
(1000, 4)
(5054, 5)
```

```
df_th
```

{"columns":[{"name":"index","rawType":"int64","type":"integer"},
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{"name":"TransactionID","rawType":"int64","type":"integer"},
{"name":"TransactionDate","rawType":"datetime64[ns]","type":"datetime"
},{"name":"AmountSpent","rawType":"float64","type":"float"},
{"name":"ProductCategory","rawType":"object","type":"string"}],"ref":"
82ed36f3-a28b-4ad1-aff2-c90ee931781a","rows":[["0","1","7194","2022-
03-27 00:00:00","416.5","Electronics"],["1","2","7250","2022-08-08

```
00:00:00","54.96","Clothing"],["2","2","9660","2022-07-25
00:00:00","197.5","Electronics"],["3","2","2998","2022-01-25
00:00:00","101.31","Furniture"],["4","2","1228","2022-07-24
00:00:00","397.37","Clothing"],["5","2","8903","2022-01-09
00:00:00","285.21","Electronics"],["6","2","3527","2022-09-16
00:00:00","311.34","Electronics"],["7","2","9279","2022-11-19
00:00:00","199.73","Groceries"],["8","3","9839","2022-10-08
00:00:00","241.06","Books"],["9","3","7364","2022-08-15
00:00:00","51.07","Clothing"],["10","3","4967","2022-09-17
00:00:00","419.95","Furniture"],["11","3","1646","2022-07-09
00:00:00","287.72","Groceries"],["12","3","7806","2022-03-02
00:00:00","299.86","Groceries"],["13","3","7329","2022-02-11
00:00:00","403.32","Furniture"],["14","4","3394","2022-07-31
00:00:00","125.64","Electronics"],["15","4","1211","2022-12-01
00:00:00","123.59","Groceries"],["16","4","4235","2022-12-22
00:00:00","241.45","Electronics"],["17","4","3419","2022-12-27
00:00:00","44.22","Clothing"],["18","4","7670","2022-05-22
00:00:00","382.39","Furniture"],["19","5","1742","2022-02-21
00:00:00","475.69","Groceries"],["20","5","9349","2022-08-12
00:00:00","178.91","Furniture"],["21","5","7200","2022-12-02
00:00:00","373.51","Groceries"],["22","5","4938","2022-10-21
00:00:00","155.76","Electronics"],["23","5","5357","2022-07-04
00:00:00","308.8","Electronics"],["24","5","6791","2022-08-31
00:00:00","219.98","Furniture"],["25","5","7592","2022-12-21
00:00:00","218.98","Electronics"],["26","5","9249","2022-05-25
00:00:00","69.86","Groceries"],["27","6","6635","2022-08-11
00:00:00","365.57","Books"],["28","6","3772","2022-10-29
00:00:00","448.86","Clothing"],["29","6","6237","2022-08-09
00:00:00","41.7","Furniture"],["30","6","8661","2022-07-03
00:00:00","104.0","Furniture"],["31","6","9155","2022-10-18
00:00:00","204.16","Electronics"],["32","7","8762","2022-10-24
00:00:00","86.73","Books"],["33","8","4215","2022-10-25
00:00:00","263.24","Books"],["34","8","2500","2022-11-09
00:00:00","483.91","Clothing"],["35","8","1383","2022-07-06
00:00:00","240.92","Books"],["36","8","6171","2022-06-10
00:00:00","346.24","Clothing"],["37","8","1807","2022-07-13
00:00:00","253.68","Furniture"],["38","8","5759","2022-09-26
00:00:00","161.56","Electronics"],["39","8","9841","2022-03-10
00:00:00","297.33","Furniture"],["40","9","7332","2022-06-02
00:00:00","96.67","Electronics"],["41","9","4938","2022-06-11
00:00:00","472.21","Clothing"],["42","9","9647","2022-01-13
00:00:00","44.26","Groceries"],["43","9","9438","2022-10-19
00:00:00","378.14","Groceries"],["44","9","4713","2022-05-26
00:00:00","325.96","Clothing"],["45","10","3487","2022-09-07
00:00:00","5.86","Furniture"],["46","10","7614","2022-10-31
00:00:00","35.29","Clothing"],["47","10","5052","2022-08-02
00:00:00","303.4","Groceries"],["48","10","4074","2022-09-08
00:00:00","223.85","Furniture"],["49","10","7393","2022-01-19
00:00:00","471.18","Furniture"]],"shape":{"columns":5,"rows":5054}}
```

```
df_th = df_th.groupby( 'CustomerID').agg( total_amount =
                                  ('AmountSpent' , 'sum' ) ,
                                  countoftransaction = ('CustomerID' ,
'count')

                                  ).reset_index()

df_th
```

```
{"columns":[{"name":"index","rawType":"int64","type":"integer"},
{"name":"CustomerID","rawType":"int64","type":"integer"},
{"name":"total_amount","rawType":"float64","type":"float"},
{"name":"countoftransaction","rawType":"int64","type":"integer"}],"ref
":"90217265-d6b3-4173-9a7b-f718896a324a","rows":
[["0","1","416.5","1"],["1","2","1547.4199999999998","7"],
["2","3","1702.98","6"],["3","4","917.29","5"],
["4","5","2001.49","8"],["5","6","1164.29","5"],["6","7","86.73","1"],
["7","8","2046.88","7"],["8","9","1317.24","5"],
["9","10","1397.36","7"],["10","11","1733.83","5"],
["11","12","87.1","1"],["12","13","392.02","3"],
["13","14","2843.59","9"],["14","15","1914.02","8"],
["15","16","2019.79","9"],["16","17","1625.27","7"],
["17","18","951.3800000000001","5"],["18","19","1017.26","5"],
["19","20","2775.85","9"],["20","21","913.02","5"],
["21","22","1582.73","6"],["22","23","1490.74","4"],
["23","24","1143.22","5"],["24","25","764.77","3"],
["25","26","571.76","3"],["26","27","2210.6","8"],
["27","28","1702.26","6"],["28","29","853.0699999999999","3"],
["29","30","706.66","2"],["30","31","1108.56","5"],
["31","32","1225.52","5"],["32","33","689.0","2"],
["33","34","1886.4","9"],["34","35","779.8399999999999","3"],
["35","36","1321.5500000000002","6"],["36","37","3166.88","9"],
["37","38","874.86","3"],["38","39","1191.94","5"],
["39","40","1578.3500000000001","7"],["40","41","363.22","2"],
["41","42","530.61","3"],["42","43","2213.63","7"],
["43","44","687.8199999999999","3"],["44","45","300.42","1"],
["45","46","134.67","1"],["46","47","1466.37","7"],
["47","48","1597.29","7"],["48","49","641.48","3"],
["49","50","1514.62","4"]],"shape":{"columns":3,"rows":1000}}
```

```
print(df_churn['CustomerID'].nunique())
print(df_cd['CustomerID'].nunique())
print(df_cs['CustomerID'].nunique())
print(df_oa['CustomerID'].nunique())
```

```
1000
1000
668
1000
```

```
# the transaction history column  has 5000+ rows and the dat that it
hold is not useful for us
# we will drop it

df_final = df_cd.merge(df_churn , on = 'CustomerID' , how = 'left') \
                .merge(df_th  , on = 'CustomerID' , how = 'left') \
                .merge(df_oa , on = 'CustomerID' , how = 'left') \
                .merge(df_cs , on = 'CustomerID' , how = 'left')

df_final.shape
```

```
(1334, 15)
```

```
df_final.duplicated().sum()
```

```
np.int64(0)
```

```
df_final.columns
# we have combined the dat from all the sheets and now we will drop
the unwanted columsn which don't have any information
```

```
Index(['CustomerID', 'Age', 'Gender', 'MaritalStatus', 'IncomeLevel',
       'ChurnStatus', 'total_amount', 'countoftransaction',
'LastLoginDate',
       'LoginFrequency', 'ServiceUsage', 'InteractionID',
'InteractionDate',
       'InteractionType', 'ResolutionStatus'],
      dtype='object')
```

```
# the columsn like transaction date , transaction id
#  interaction , data , intereaction id
# gender  , are irrelevent and we will drop them

# checking for missing values
df_final.isnull().sum()
```

{"columns":[{"name":"index","rawType":"object","type":"string"},
{"name":"0","rawType":"int64","type":"integer"}],"ref":"ff3d17e3-a682-
4357-944d-c2c336310bcd","rows":[["CustomerID","0"],["Age","0"],
["Gender","0"],["MaritalStatus","0"],["IncomeLevel","0"],
["ChurnStatus","0"],["total_amount","0"],["countoftransaction","0"],
["LastLoginDate","0"],["LoginFrequency","0"],["ServiceUsage","0"],
["InteractionID","332"],["InteractionDate","332"],
["InteractionType","332"],["ResolutionStatus","332"]],"shape":
{"columns":1,"rows":15}}

```
df_final
```

{"columns":[{"name":"index","rawType":"int64","type":"integer"},
{"name":"CustomerID","rawType":"int64","type":"integer"},
{"name":"Age","rawType":"int64","type":"integer"},
{"name":"Gender","rawType":"object","type":"string"},

```
{"name":"MaritalStatus","rawType":"object","type":"string"},
{"name":"IncomeLevel","rawType":"object","type":"string"},
{"name":"ChurnStatus","rawType":"int64","type":"integer"},
{"name":"total_amount","rawType":"float64","type":"float"},
{"name":"countoftransaction","rawType":"int64","type":"integer"},
{"name":"LastLoginDate","rawType":"datetime64[ns]","type":"datetime"},
{"name":"LoginFrequency","rawType":"int64","type":"integer"},
{"name":"ServiceUsage","rawType":"object","type":"string"},
{"name":"InteractionID","rawType":"float64","type":"float"},
{"name":"InteractionDate","rawType":"datetime64[ns]","type":"datetime"
},{"name":"InteractionType","rawType":"object","type":"unknown"},
{"name":"ResolutionStatus","rawType":"object","type":"unknown"}],"ref"
:"778ffd05-0bbd-43af-b3e6-2f10dce0fa31","rows":
[["0","1","62","M","Single","Low","0","416.5","1","2023-10-21
00:00:00","34","Mobile App","6363.0","2022-03-31
00:00:00","Inquiry","Resolved"],
["1","2","65","M","Married","Low","1","1547.4199999999998","7","2023-
12-05 00:00:00","5","Website","3329.0","2022-03-17
00:00:00","Inquiry","Resolved"],
["2","3","18","M","Single","Low","0","1702.98","6","2023-11-15
00:00:00","3","Website","9976.0","2022-08-24
00:00:00","Inquiry","Resolved"],
["3","4","21","M","Widowed","Low","0","917.29","5","2023-08-25
00:00:00","2","Website","7354.0","2022-11-18
00:00:00","Inquiry","Resolved"],
["4","4","21","M","Widowed","Low","0","917.29","5","2023-08-25
00:00:00","2","Website","5393.0","2022-07-03
00:00:00","Inquiry","Unresolved"],
["5","5","21","M","Divorced","Medium","0","2001.49","8","2023-10-27
00:00:00","41","Website",null,null,null,null],
["6","6","57","F","Divorced","Medium","0","1164.29","5","2023-09-17
00:00:00","2","Website","2358.0","2022-05-05
00:00:00","Feedback","Resolved"],
["7","7","27","F","Married","High","0","86.73","1","2023-01-07
00:00:00","32","Mobile App",null,null,null,null],
["8","8","37","M","Single","Low","1","2046.88","7","2023-04-22
00:00:00","17","Online Banking","4191.0","2022-04-29
00:00:00","Inquiry","Unresolved"],
["9","8","37","M","Single","Low","1","2046.88","7","2023-04-22
00:00:00","17","Online Banking","8937.0","2022-09-13
00:00:00","Feedback","Unresolved"],
["10","9","39","M","Divorced","High","0","1317.24","5","2023-06-27
00:00:00","24","Website","7813.0","2022-08-15
00:00:00","Inquiry","Resolved"],
["11","10","68","M","Married","High","1","1397.36","7","2023-01-13
00:00:00","29","Online Banking",null,null,null,null],
["12","11","54","M","Divorced","Medium","0","1733.83","5","2023-01-22
00:00:00","30","Online Banking","6610.0","2022-10-28
00:00:00","Feedback","Resolved"],
["13","11","54","M","Divorced","Medium","0","1733.83","5","2023-01-22
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00:00:00","Feedback","Unresolved"],
["14","12","41","F","Married","Low","0","87.1","1","2023-12-31
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00:00:00","Feedback","Resolved"],
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00:00:00","43","Website","7872.0","2022-01-12
00:00:00","Inquiry","Unresolved"],
["16","13","24","F","Divorced","Low","0","392.02","3","2023-07-05
00:00:00","10","Mobile App","9681.0","2022-07-27
00:00:00","Complaint","Resolved"],
["17","14","42","M","Widowed","Medium","0","2843.59","9","2023-01-10
00:00:00","26","Online Banking","4459.0","2022-07-25
00:00:00","Complaint","Unresolved"],
["18","14","42","M","Widowed","Medium","0","2843.59","9","2023-01-10
00:00:00","26","Online Banking","8823.0","2022-07-29
00:00:00","Feedback","Resolved"],
["19","15","42","M","Divorced","Medium","0","1914.02","8","2023-06-15
00:00:00","44","Online Banking","6644.0","2022-10-18
00:00:00","Feedback","Unresolved"],
["20","15","42","M","Divorced","Medium","0","1914.02","8","2023-06-15
00:00:00","44","Online Banking","3914.0","2022-02-04
00:00:00","Complaint","Unresolved"],
["21","16","30","F","Single","Medium","1","2019.79","9","2023-03-15
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00:00:00","Inquiry","Resolved"],
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00:00:00","41","Online Banking","9278.0","2022-09-08
00:00:00","Inquiry","Resolved"],
["23","17","19","M","Married","Low","0","1625.27","7","2023-09-03
00:00:00","8","Online Banking","2246.0","2022-05-11
00:00:00","Inquiry","Unresolved"],
["24","17","19","M","Married","Low","0","1625.27","7","2023-09-03
00:00:00","8","Online Banking","7540.0","2022-05-06
00:00:00","Inquiry","Resolved"],
["25","18","56","F","Married","High","1","951.3800000000001","5","2023
-11-24 00:00:00","37","Website","9487.0","2022-11-08
00:00:00","Inquiry","Unresolved"],
["26","19","57","F","Divorced","High","0","1017.26","5","2023-03-08
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00:00:00","Complaint","Unresolved"],
["27","19","57","F","Divorced","High","0","1017.26","5","2023-03-08
00:00:00","39","Online Banking","8180.0","2022-04-18
00:00:00","Complaint","Unresolved"],
["28","20","41","M","Single","Low","0","2775.85","9","2023-08-15
00:00:00","16","Website","9094.0","2022-07-19
00:00:00","Feedback","Resolved"],
["29","21","64","M","Divorced","High","0","913.02","5","2023-06-16
00:00:00","18","Website",null,null,null,null],
["30","22","42","F","Divorced","Low","0","1582.73","6","2023-05-06
00:00:00","42","Mobile App","2931.0","2022-01-07
00:00:00","Inquiry","Resolved"],
["31","22","42","F","Divorced","Low","0","1582.73","6","2023-05-06
00:00:00","42","Mobile App","6355.0","2022-08-06
00:00:00","Inquiry","Resolved"],
["32","23","35","F","Divorced","Low","0","1490.74","4","2023-07-07
00:00:00","19","Mobile App","4991.0","2022-03-18
00:00:00","Complaint","Unresolved"],
["33","23","35","F","Divorced","Low","0","1490.74","4","2023-07-07
00:00:00","19","Mobile App","6401.0","2022-02-23
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["34","24","55","M","Widowed","Medium","0","1143.22","5","2023-10-04
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00:00:00","Complaint","Resolved"],
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00:00:00","27","Mobile App","8432.0","2022-12-06
00:00:00","Feedback","Resolved"],
["36","26","31","M","Single","Medium","1","571.76","3","2023-09-29
00:00:00","45","Mobile App","3912.0","2022-12-12
00:00:00","Complaint","Resolved"],
["37","27","26","M","Widowed","Medium","0","2210.6","8","2023-10-01
00:00:00","22","Mobile App","9414.0","2022-06-13
00:00:00","Feedback","Unresolved"],
["38","28","27","F","Widowed","High","0","1702.26","6","2023-10-26
00:00:00","42","Online Banking","4174.0","2022-04-14
00:00:00","Complaint","Unresolved"],
["39","28","27","F","Widowed","High","0","1702.26","6","2023-10-26
00:00:00","42","Online Banking","2029.0","2022-12-01
00:00:00","Inquiry","Unresolved"],
["40","29","38","F","Divorced","Medium","0","853.0699999999999","3","2
023-09-02 00:00:00","34","Website","8538.0","2022-09-13
00:00:00","Inquiry","Resolved"],
["41","29","38","F","Divorced","Medium","0","853.0699999999999","3","2
023-09-02 00:00:00","34","Website","3691.0","2022-04-14
00:00:00","Feedback","Unresolved"],
["42","30","69","M","Divorced","High","0","706.66","2","2023-07-12
00:00:00","38","Website","3289.0","2022-04-04
00:00:00","Complaint","Resolved"],
["43","30","69","M","Divorced","High","0","706.66","2","2023-07-12
00:00:00","38","Website","4606.0","2022-10-16
00:00:00","Complaint","Unresolved"],
["44","31","34","M","Divorced","Low","0","1108.56","5","2023-08-17
00:00:00","23","Online Banking","6635.0","2022-06-18
00:00:00","Inquiry","Resolved"],
["45","31","34","M","Divorced","Low","0","1108.56","5","2023-08-17
00:00:00","23","Online Banking","5130.0","2022-05-09
00:00:00","Complaint","Resolved"],
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["46","32","69","F","Married","High","0","1225.52","5","2023-01-06
00:00:00","48","Mobile App",null,null,null,null],
["47","33","23","M","Divorced","High","1","689.0","2","2023-05-19
00:00:00","24","Mobile App","8219.0","2022-05-30
00:00:00","Feedback","Resolved"],
["48","34","33","M","Widowed","High","0","1886.4","9","2023-04-03
00:00:00","44","Online Banking","7853.0","2022-07-02
00:00:00","Feedback","Resolved"],
["49","34","33","M","Widowed","High","0","1886.4","9","2023-04-03
00:00:00","44","Online Banking","5032.0","2022-05-19
00:00:00","Feedback","Unresolved"]],"shape":
{"columns":15,"rows":1334}}

```
df_final.drop(columns = [ 'InteractionDate'  ,
'InteractionID' ,'InteractionType' ,'LastLoginDate' ] , inplace = True
)
#we will drop use less columns
```

```
df_final.columns
# only relevant columns are left now
```

```
Index(['CustomerID', 'Age', 'Gender', 'MaritalStatus', 'IncomeLevel',
       'ChurnStatus', 'total_amount', 'countoftransaction',
'LoginFrequency',
       'ServiceUsage', 'ResolutionStatus'],
      dtype='object')
```

```
df_final
```

{"columns":[{"name":"index","rawType":"int64","type":"integer"},
{"name":"CustomerID","rawType":"int64","type":"integer"},
{"name":"Age","rawType":"int64","type":"integer"},
{"name":"Gender","rawType":"object","type":"string"},
{"name":"MaritalStatus","rawType":"object","type":"string"},
{"name":"IncomeLevel","rawType":"object","type":"string"},
{"name":"ChurnStatus","rawType":"int64","type":"integer"},
{"name":"total_amount","rawType":"float64","type":"float"},
{"name":"countoftransaction","rawType":"int64","type":"integer"},
{"name":"LoginFrequency","rawType":"int64","type":"integer"},
{"name":"ServiceUsage","rawType":"object","type":"string"},
{"name":"ResolutionStatus","rawType":"object","type":"unknown"}],"ref"
:"ddec546d-6a94-414d-823c-42df0ba24210","rows":
[["0","1","62","M","Single","Low","0","416.5","1","34","Mobile
App","Resolved"],
["1","2","65","M","Married","Low","1","1547.4199999999998","7","5","We
bsite","Resolved"],
["2","3","18","M","Single","Low","0","1702.98","6","3","Website","Reso
lved"],
["3","4","21","M","Widowed","Low","0","917.29","5","2","Website","Reso
lved"],

```
["4","4","21","M","Widowed","Low","0","917.29","5","2","Website","Unre
solved"],
["5","5","21","M","Divorced","Medium","0","2001.49","8","41","Website"
,null],
["6","6","57","F","Divorced","Medium","0","1164.29","5","2","Website",
"Resolved"],
["7","7","27","F","Married","High","0","86.73","1","32","Mobile
App",null],
["8","8","37","M","Single","Low","1","2046.88","7","17","Online
Banking","Unresolved"],
["9","8","37","M","Single","Low","1","2046.88","7","17","Online
Banking","Unresolved"],
["10","9","39","M","Divorced","High","0","1317.24","5","24","Website",
"Resolved"],
["11","10","68","M","Married","High","1","1397.36","7","29","Online
Banking",null],
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Banking","Resolved"],
["13","11","54","M","Divorced","Medium","0","1733.83","5","30","Online
Banking","Unresolved"],
["14","12","41","F","Married","Low","0","87.1","1","43","Website","Res
olved"],
["15","12","41","F","Married","Low","0","87.1","1","43","Website","Unr
esolved"],
["16","13","24","F","Divorced","Low","0","392.02","3","10","Mobile
App","Resolved"],
["17","14","42","M","Widowed","Medium","0","2843.59","9","26","Online
Banking","Unresolved"],
["18","14","42","M","Widowed","Medium","0","2843.59","9","26","Online
Banking","Resolved"],
["19","15","42","M","Divorced","Medium","0","1914.02","8","44","Online
Banking","Unresolved"],
["20","15","42","M","Divorced","Medium","0","1914.02","8","44","Online
Banking","Unresolved"],
["21","16","30","F","Single","Medium","1","2019.79","9","41","Online
Banking","Resolved"],
["22","16","30","F","Single","Medium","1","2019.79","9","41","Online
Banking","Resolved"],
["23","17","19","M","Married","Low","0","1625.27","7","8","Online
Banking","Unresolved"],
["24","17","19","M","Married","Low","0","1625.27","7","8","Online
Banking","Resolved"],
["25","18","56","F","Married","High","1","951.3800000000001","5","37",
"Website","Unresolved"],
["26","19","57","F","Divorced","High","0","1017.26","5","39","Online
Banking","Unresolved"],
["27","19","57","F","Divorced","High","0","1017.26","5","39","Online
Banking","Unresolved"],
["28","20","41","M","Single","Low","0","2775.85","9","16","Website","R
esolved"],
["29","21","64","M","Divorced","High","0","913.02","5","18","Website",
null],
["30","22","42","F","Divorced","Low","0","1582.73","6","42","Mobile
App","Resolved"],
["31","22","42","F","Divorced","Low","0","1582.73","6","42","Mobile
App","Resolved"],
["32","23","35","F","Divorced","Low","0","1490.74","4","19","Mobile
App","Unresolved"],
["33","23","35","F","Divorced","Low","0","1490.74","4","19","Mobile
App","Resolved"],
["34","24","55","M","Widowed","Medium","0","1143.22","5","12","Mobile
App","Resolved"],
["35","25","43","F","Married","Low","0","764.77","3","27","Mobile
App","Resolved"],
["36","26","31","M","Single","Medium","1","571.76","3","45","Mobile
App","Resolved"],
["37","27","26","M","Widowed","Medium","0","2210.6","8","22","Mobile
App","Unresolved"],
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Banking","Unresolved"],
["39","28","27","F","Widowed","High","0","1702.26","6","42","Online
Banking","Unresolved"],
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4","Website","Resolved"],
["41","29","38","F","Divorced","Medium","0","853.0699999999999","3","3
4","Website","Unresolved"],
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"Resolved"],
["43","30","69","M","Divorced","High","0","706.66","2","38","Website",
"Unresolved"],
["44","31","34","M","Divorced","Low","0","1108.56","5","23","Online
Banking","Resolved"],
["45","31","34","M","Divorced","Low","0","1108.56","5","23","Online
Banking","Resolved"],
["46","32","69","F","Married","High","0","1225.52","5","48","Mobile
App",null],
["47","33","23","M","Divorced","High","1","689.0","2","24","Mobile
App","Resolved"],
["48","34","33","M","Widowed","High","0","1886.4","9","44","Online
Banking","Resolved"],
["49","34","33","M","Widowed","High","0","1886.4","9","44","Online
Banking","Unresolved"]],"shape":{"columns":11,"rows":1334}}
```

```
# we will fill the missing values of resolution status  with no
problem
df_final['ResolutionStatus'].fillna('No Problem', inplace=True)
```

```
C:\Users\Ayush\AppData\Local\Temp\ipykernel_3312\983418897.py:2:
FutureWarning: A value is trying to be set on a copy of a DataFrame or
```

```
Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never
work because the intermediate object on which we are setting values
always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try
using 'df.method({col: value}, inplace=True)' or df[col] =
df[col].method(value) instead, to perform the operation inplace on the
original object.


  df_final['ResolutionStatus'].fillna('No Problem', inplace=True)
```

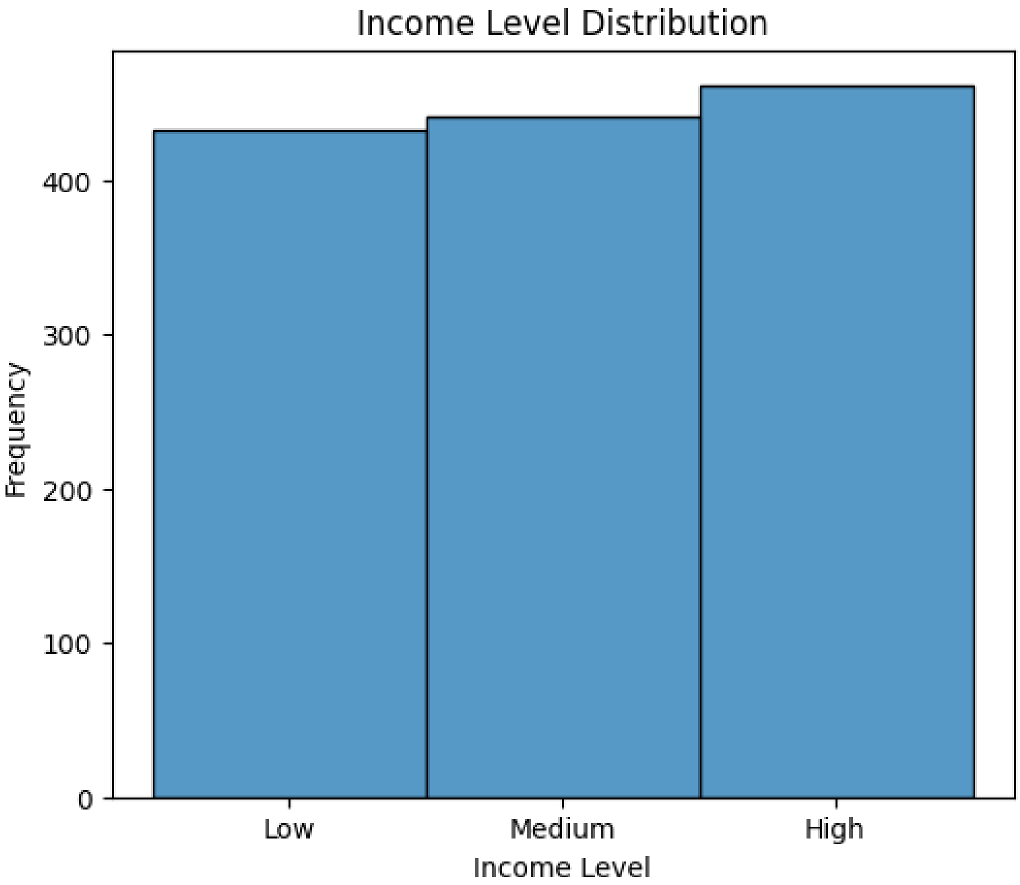
```
# now we will replace resolved and noproblem
```

EDA

```
df_final['CustomerID'].nunique()
```

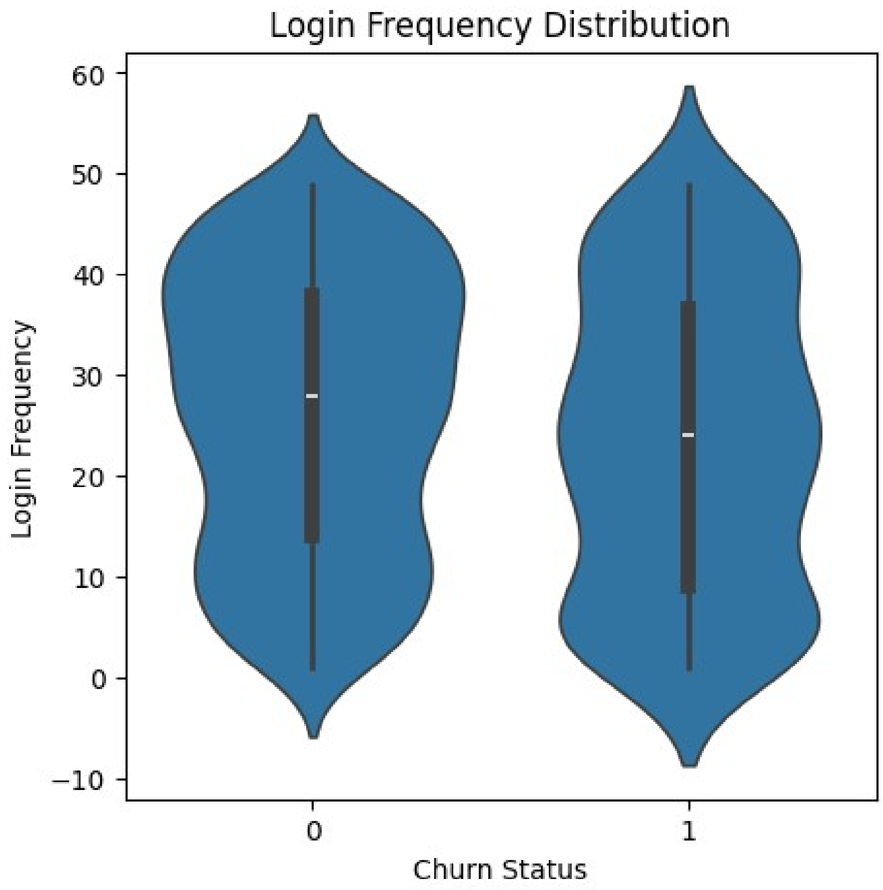
```
1000
```

```
# histogram for income column
plt.figure(figsize=(6 , 5 ))
sns.histplot(df_final['IncomeLevel'] )
plt.title('Income Level Distribution')
plt.xlabel('Income Level')
plt.ylabel('Frequency')
plt.show()
print( df_final['IncomeLevel'].value_counts())
```

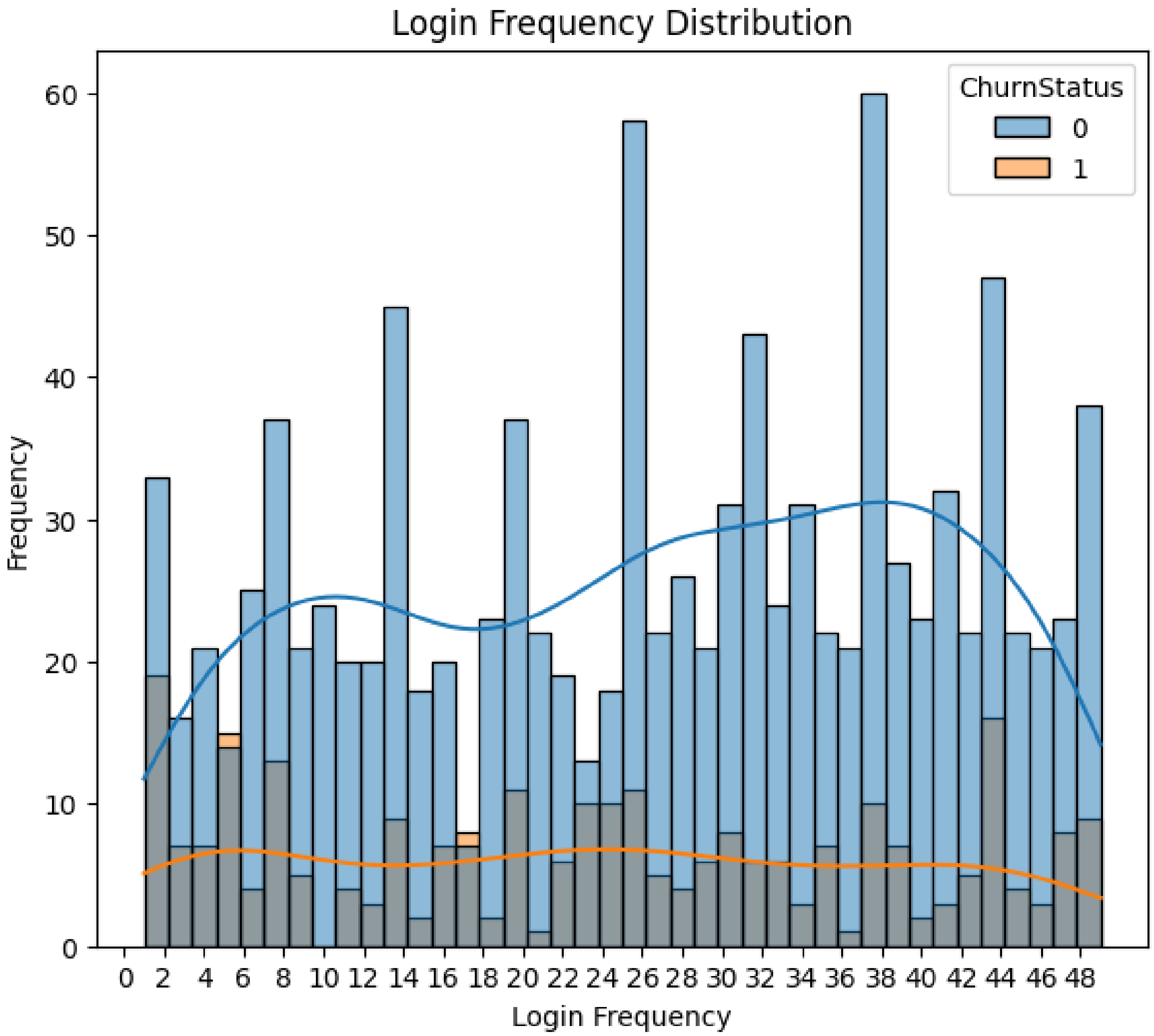


```
IncomeLevel
High      461
Medium    441
Low       432
Name: count, dtype: int64
```

```
# violin plot for LoginFrequency
plt.figure(figsize=(5, 5))
sns.violinplot(x='ChurnStatus' , y = 'LoginFrequency'  , data=df_final
)
plt.title('Login Frequency Distribution')
plt.xlabel('Churn Status')
plt.ylabel('Login Frequency')
plt.show()
```

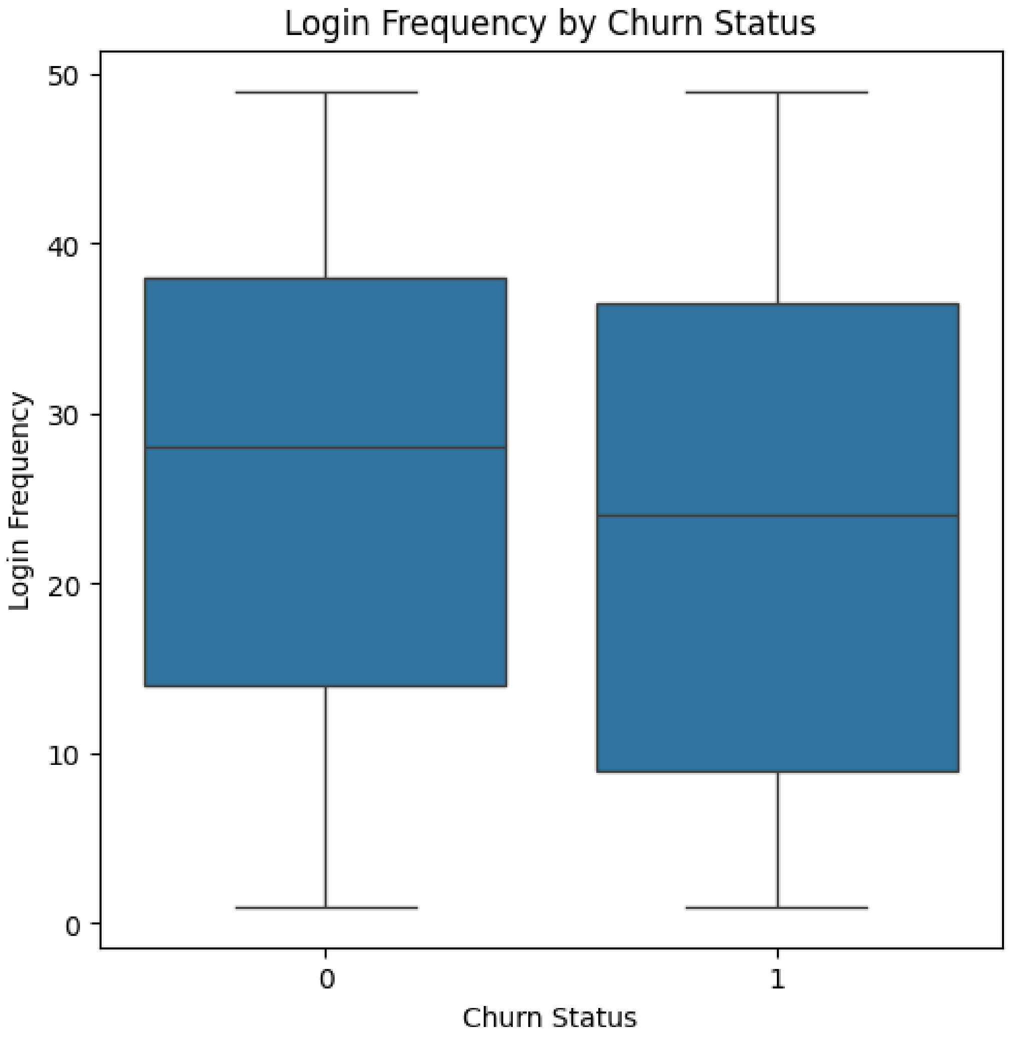


```
# histogram for login frequqncy
plt.figure(figsize=(7, 6))
sns.histplot( data = df_final , x = 'LoginFrequency' ,  bins=40 ,
kde=True , hue = 'ChurnStatus' )
plt.title('Login Frequency Distribution')
plt.xlabel('Login Frequency')
plt.ylabel('Frequency')
plt.xticks( np.arange( 0 ,50 , 2 )   )
plt.show()
```

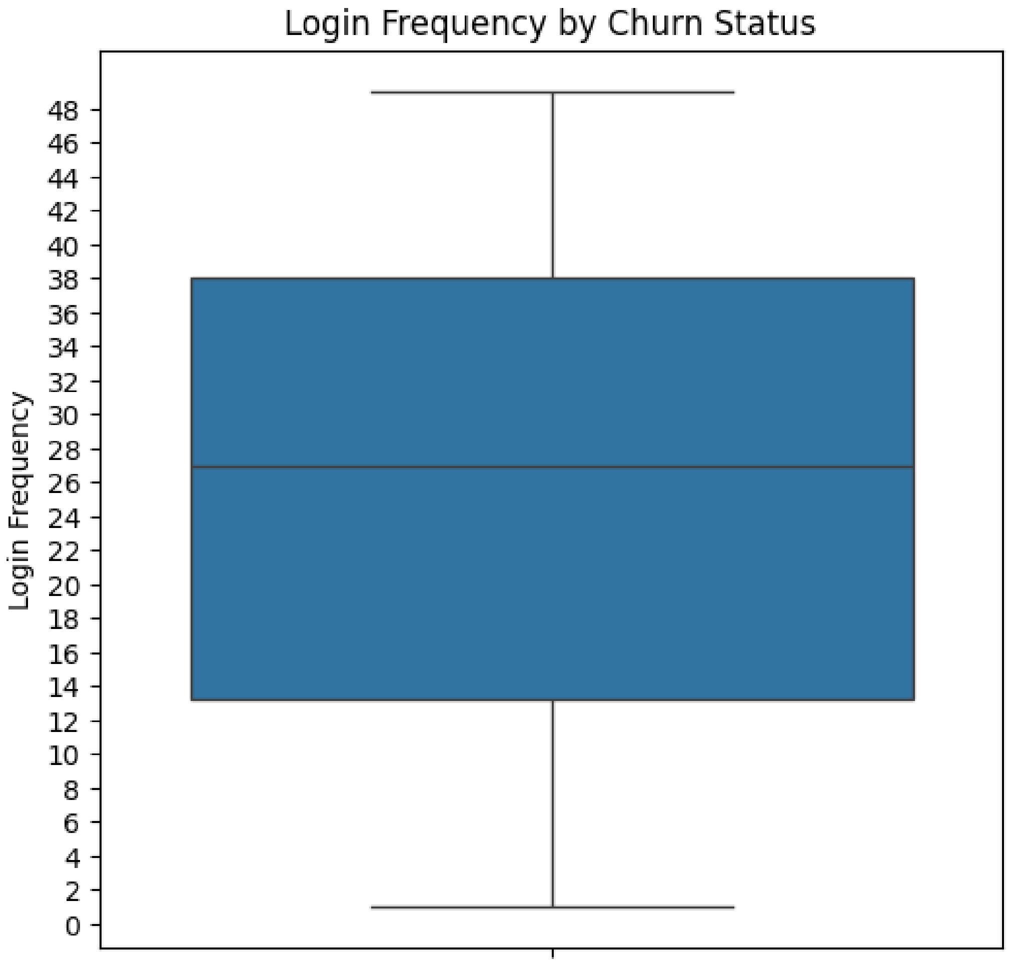


```
plt.figure(figsize=(6, 6))
sns.boxplot(data=df_final, x='ChurnStatus', y='LoginFrequency')
plt.title('Login Frequency by Churn Status')
plt.xlabel('Churn Status')
plt.ylabel('Login Frequency')
plt.show()

# the people who are not leaving ar have higher login frequnce on an
average
```

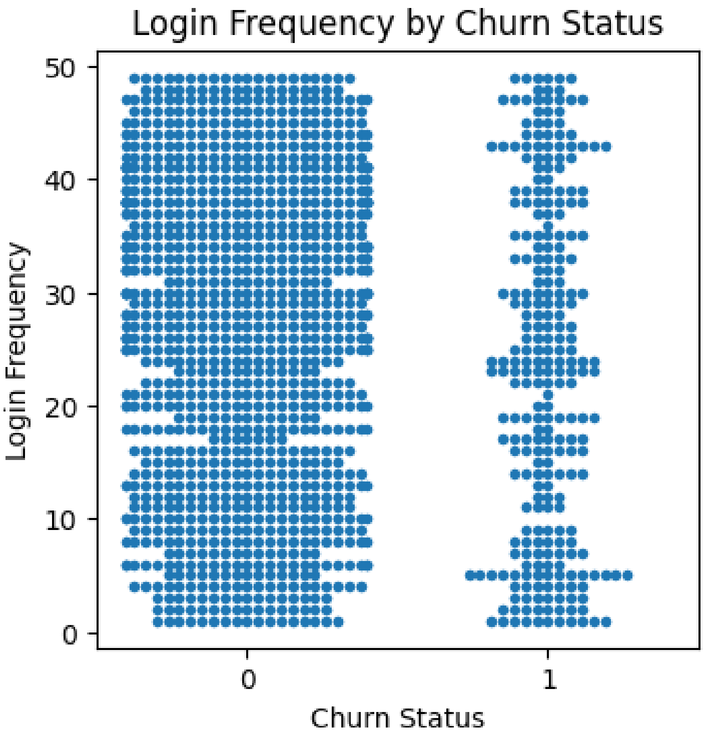


```
plt.figure(figsize=(6, 6))
sns.boxplot(data=df_final, y = 'LoginFrequency')
plt.title('Login Frequency by Churn Status')
plt.ylabel('Login Frequency')
plt.yticks( np.arange( 0 ,50 , 2 )   )
plt.show()
```



```
plt.figure(figsize=(4, 4))
sns.swarmplot(data=df_final, x='ChurnStatus', y='LoginFrequency' ,
size =4  )
plt.title('Login Frequency by Churn Status')
plt.xlabel('Churn Status')
plt.ylabel('Login Frequency')
plt.show()
# the people who are  leaving have lower  login frequency
```

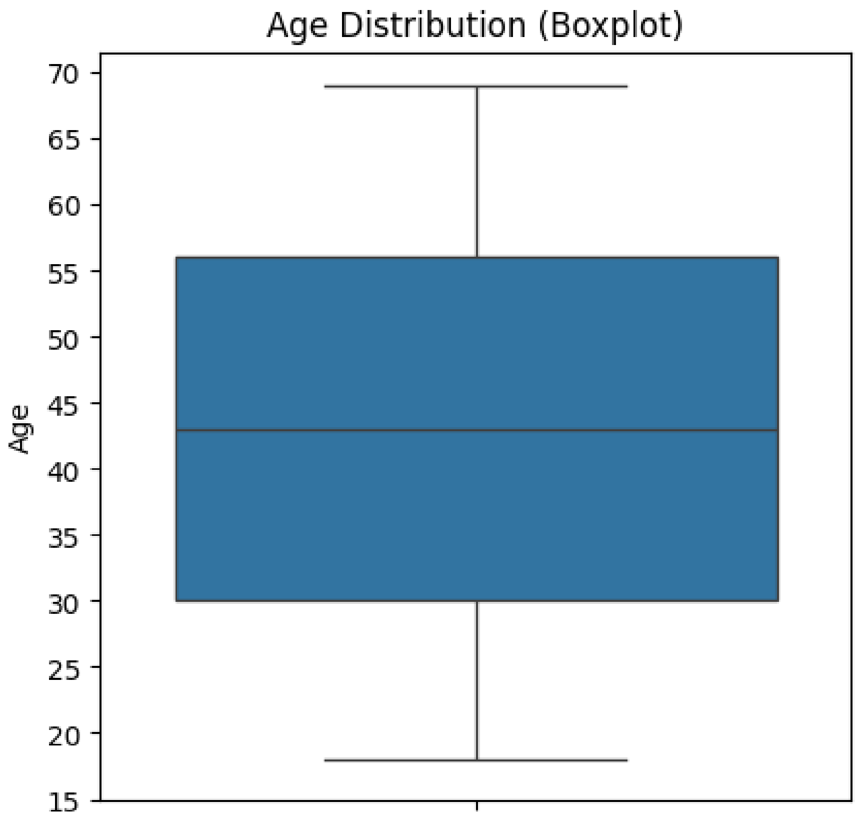
```
e:\DATA\quantinum forage\.venv\Lib\site-packages\seaborn\
categorical.py:3399: UserWarning: 11.0% of the points cannot be
placed; you may want to decrease the size of the markers or use
stripplot.
  warnings.warn(msg, UserWarning)
```



```
# box plot and histogram for age
q1 = df_final['Age'].quantile(0.25)
q2 = df_final['Age'].quantile(0.50)
q3 = df_final['Age'].quantile(0.75)
print( "25 % quartile :" , q1 , "       50 % quartile :"  , q2 ,  "
75 % quartile:"  , q3 )

plt.figure(figsize=(5, 5))
sns.boxplot(data=df_final, y='Age')
plt.title('Age Distribution (Boxplot)')
plt.ylabel('Age')
plt.yticks( np.arange( 15, 75 , 5  ) )
plt.show()
```

```
25 % quartile : 30.0       50 % quartile : 43.0         75 % quartile:
56.0
```

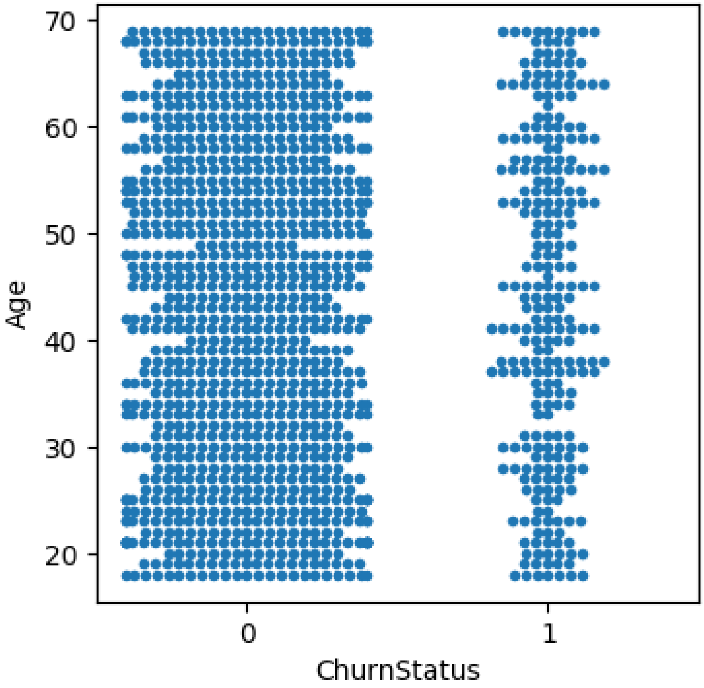


bi variate analysis using the target variable

```
# swarm plot for churn vs age
plt.figure( figsize= ( 4 ,4 ))
sns.swarmplot( data = df_final , x = 'ChurnStatus'  , y = 'Age'  ,
size = 4 )
```

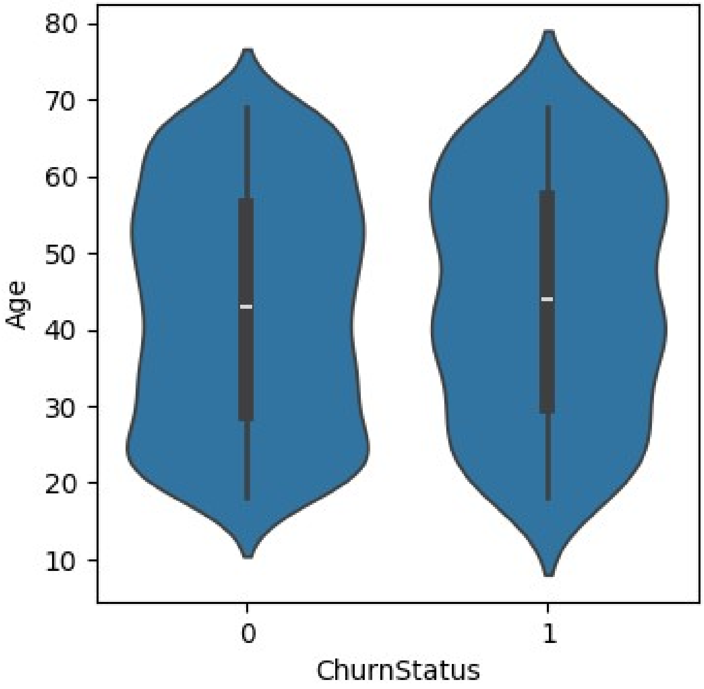
```
<Axes: xlabel='ChurnStatus', ylabel='Age'>
```

```
e:\DATA\quantinum forage\.venv\Lib\site-packages\seaborn\
categorical.py:3399: UserWarning: 7.3% of the points cannot be placed;
you may want to decrease the size of the markers or use stripplot.
  warnings.warn(msg, UserWarning)
```



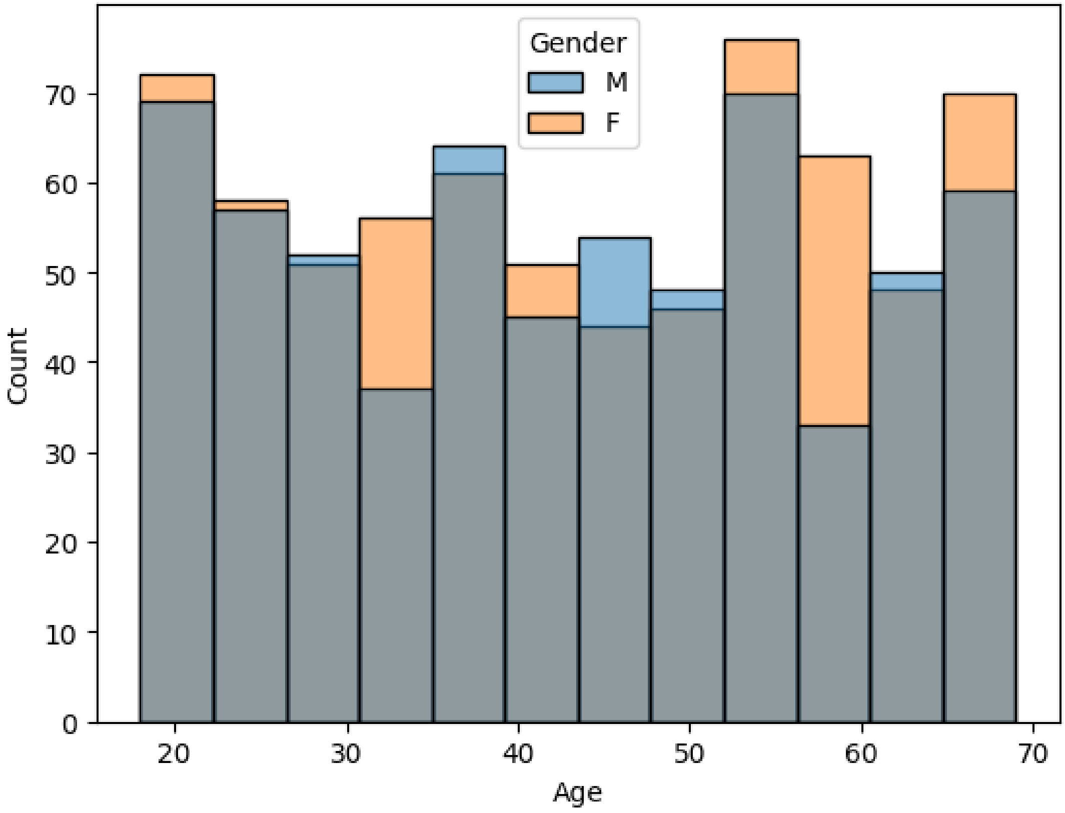
```
plt.figure(  figsize = ( 4 ,4 ) )
sns.violinplot(  x = 'ChurnStatus' , y = 'Age' , data = df_final )

<Axes: xlabel='ChurnStatus', ylabel='Age'>
```



```
plt.Figure( figsize= ( 4 , 4 ))
sns.histplot(data=df_final , x = 'Age' , hue = 'Gender' )  # split by
category (optional)

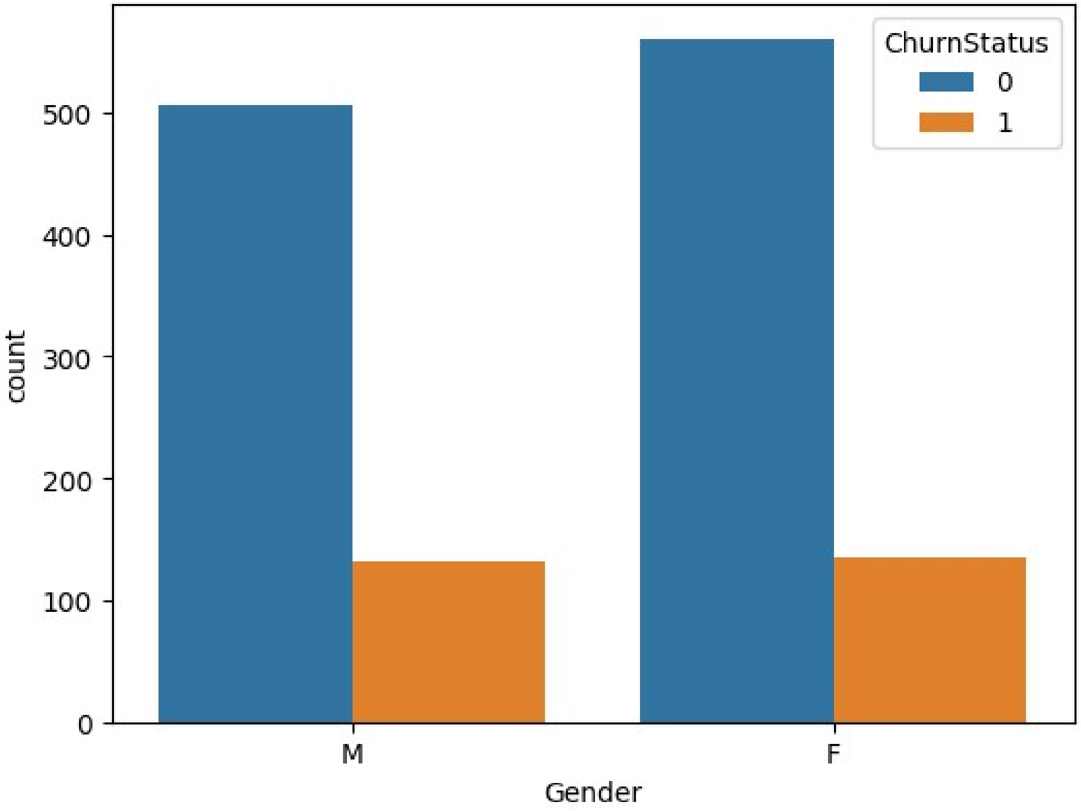
<Axes: xlabel='Age', ylabel='Count'>
```



categorical vs target variable

```
plt.Figure( figsize= ( 4 , 4 ))
sns.countplot( data = df_final  , x = 'Gender'  , hue = 'ChurnStatus'
)

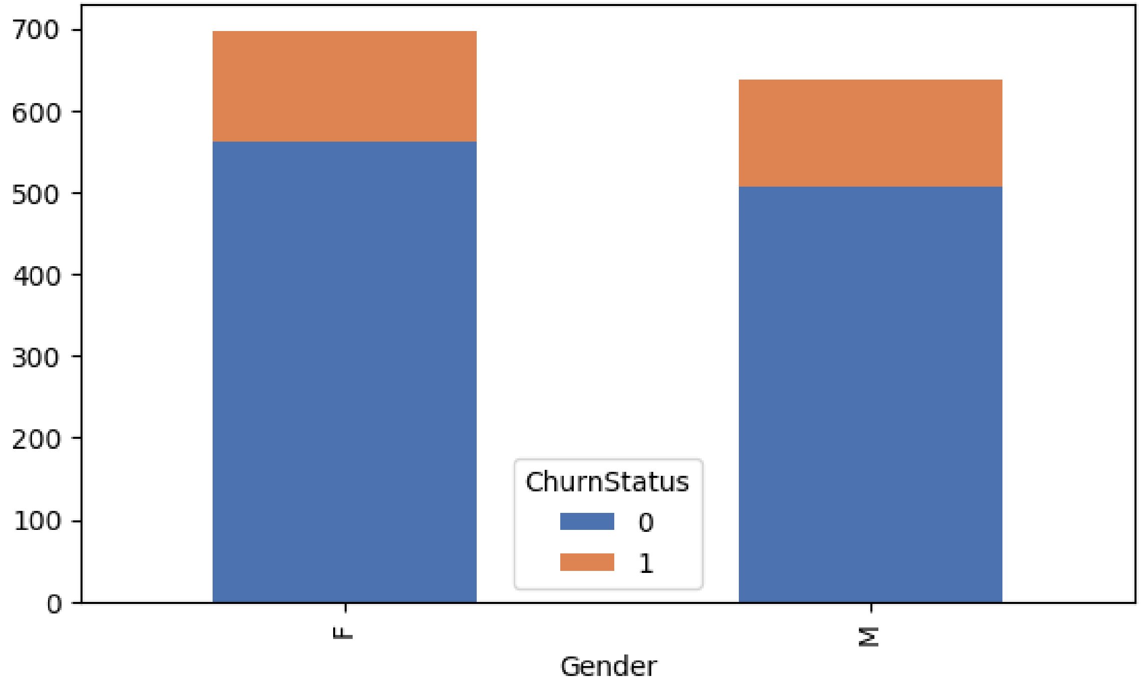
<Axes: xlabel='Gender', ylabel='count'>
```



```
counts = pd.crosstab(df_final['Gender'], df_final['ChurnStatus'])

# Plot stacked bar chart (normal, not 100%)
counts.plot(kind='bar', stacked=True, figsize=(7,4), color=['#4C72B0',
'#DD8452'])
```

```
<Axes: xlabel='Gender'>
```



```
## 100 percent stacked bar chart for marital status  vs churnstatus
crosstab = pd.crosstab( df_final['MaritalStatus'] ,
df_final['ChurnStatus'] )
crosstab2 = pd.crosstab( df_final['ResolutionStatus'] ,
df_final['ChurnStatus'] )
crosstab3 = pd.crosstab( df_final['IncomeLevel'] ,
df_final['ChurnStatus'] )


crosstab2
```

{"columns":
[{"name":"ResolutionStatus","rawType":"object","type":"string"},
{"name":"0","rawType":"int64","type":"integer"},
{"name":"1","rawType":"int64","type":"integer"}],"ref":"ee1981b9-da0f-4b4e-b7b2-d2fe7f57f5b5","rows":[["No Problem","271","61"],
["Resolved","416","107"],["Unresolved","380","99"]],"shape":
{"columns":2,"rows":3}}

```
proportion = crosstab.div( crosstab.sum(axis =1 )   , axis = 0 )
proportion2 = crosstab2.div( crosstab2.sum(axis =1 )   , axis = 0 )
proportion3 = crosstab3.div( crosstab3.sum(axis =1 )   , axis = 0 )

proportion3
```

{"columns":[{"name":"IncomeLevel","rawType":"object","type":"string"},
{"name":"0","rawType":"float64","type":"float"},
{"name":"1","rawType":"float64","type":"float"}],"ref":"6c4ca22d-8f45-4de6-9162-ee057d5331d7","rows":

```
[["High","0.8156182212581344","0.1843817787418655"],
["Low","0.7870370370370371","0.21296296296296297"],
["Medium","0.7959183673469388","0.20408163265306123"]],"shape":
{"columns":2,"rows":3}}
```

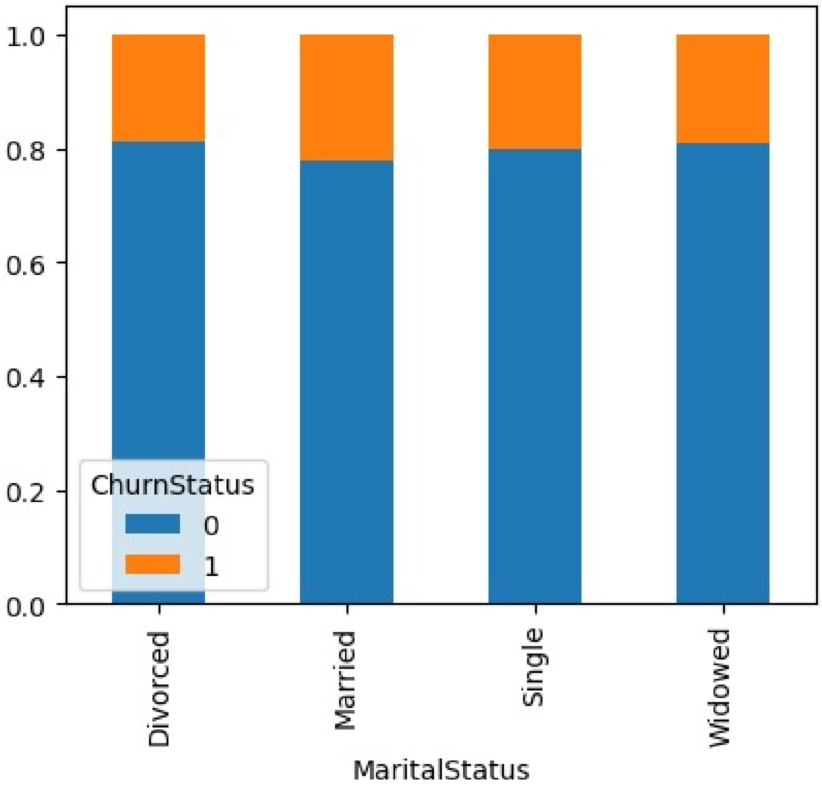
```
proportion2
```

```
{"columns":
[{"name":"ResolutionStatus","rawType":"object","type":"string"},
{"name":"0","rawType":"float64","type":"float"},
{"name":"1","rawType":"float64","type":"float"}],"ref":"f57b98dd-53a5-
49a8-8112-cf99c3f10d6f","rows":[["No
Problem","0.8162650602409639","0.18373493975903615"],
["Resolved","0.7954110898661568","0.2045889101338432"],
["Unresolved","0.7933194154488518","0.20668058455114824"]],"shape":
{"columns":2,"rows":3}}
```

```
proportion.plot( kind = 'bar'  , stacked= True  ,  figsize=( 5, 4 ) )

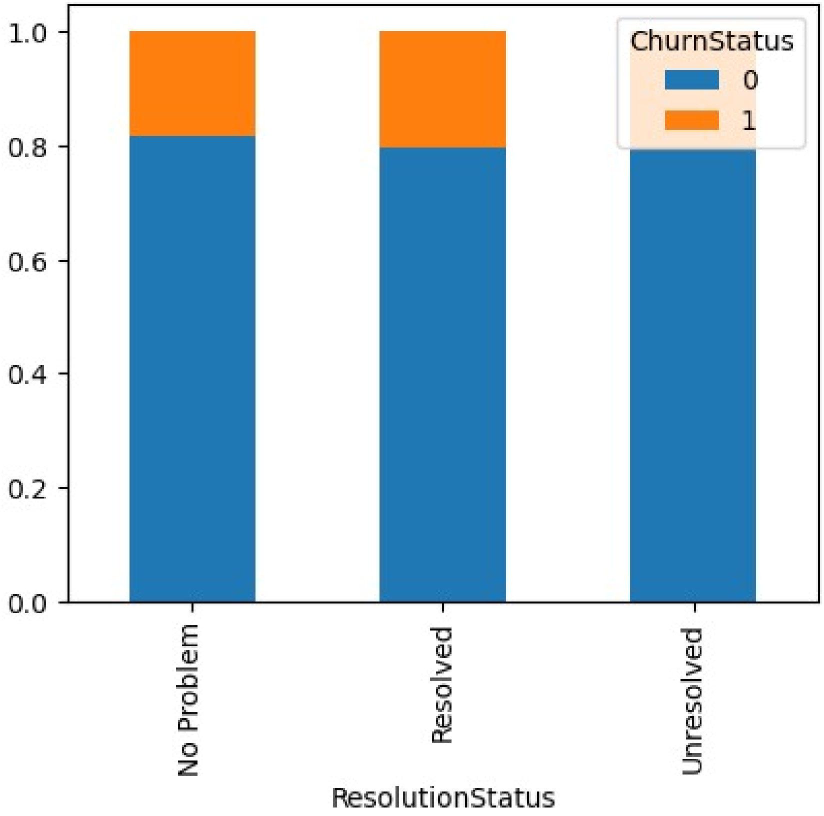
# the churn rate across all of them is almost equal nothing to find
out from  here
```

```
<Axes: xlabel='MaritalStatus'>
```



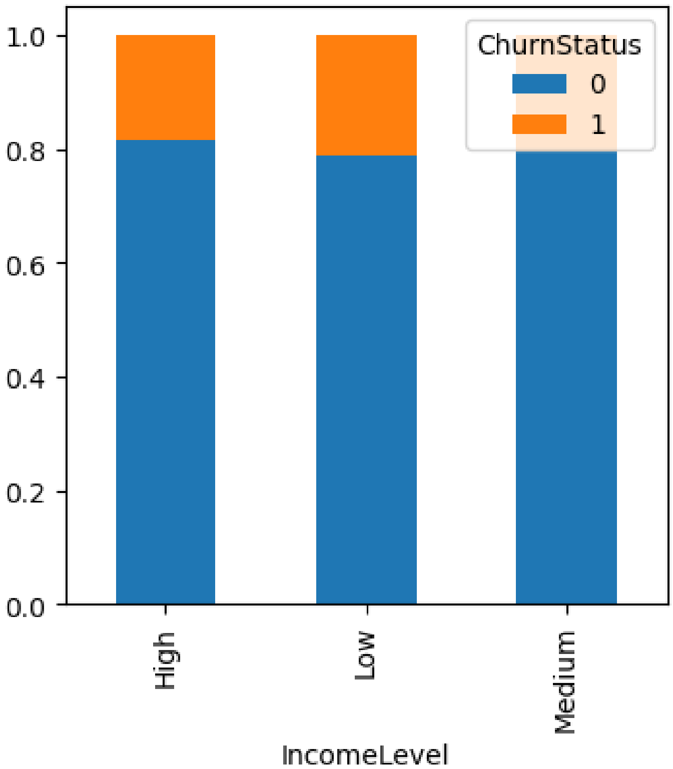
```
proportion2.plot( kind = 'bar'  , stacked= True  ,  figsize=( 5, 4 ) )
```

```
<Axes: xlabel='ResolutionStatus'>
```



```
proportion3.plot( kind= 'bar'  , stacked = True  , figsize = ( 4 , 4 )
)

<Axes: xlabel='IncomeLevel'>
```



numerical vs target

```
df_final
```

```
{"columns":[{"name":"index","rawType":"int64","type":"integer"},
{"name":"CustomerID","rawType":"int64","type":"integer"},
{"name":"Age","rawType":"int64","type":"integer"},
{"name":"Gender","rawType":"object","type":"string"},
{"name":"MaritalStatus","rawType":"object","type":"string"},
{"name":"IncomeLevel","rawType":"object","type":"string"},
{"name":"ChurnStatus","rawType":"int64","type":"integer"},
{"name":"total_amount","rawType":"float64","type":"float"},
{"name":"countoftransaction","rawType":"int64","type":"integer"},
{"name":"LoginFrequency","rawType":"int64","type":"integer"},
{"name":"ServiceUsage","rawType":"object","type":"string"},
{"name":"ResolutionStatus","rawType":"object","type":"string"}],"ref":
"97d68717-7adc-454c-a147-1466423583b3","rows":
[["0","1","62","M","Single","Low","0","416.5","1","34","Mobile
App","Resolved"],
["1","2","65","M","Married","Low","1","1547.4199999999998","7","5","We
bsite","Resolved"],
["2","3","18","M","Single","Low","0","1702.98","6","3","Website","Reso
lved"],
["3","4","21","M","Widowed","Low","0","917.29","5","2","Website","Reso
lved"],
["4","4","21","M","Widowed","Low","0","917.29","5","2","Website","Unre
solved"],
["5","5","21","M","Divorced","Medium","0","2001.49","8","41","Website"
,"No Problem"],
["6","6","57","F","Divorced","Medium","0","1164.29","5","2","Website",
"Resolved"],
["7","7","27","F","Married","High","0","86.73","1","32","Mobile
App","No Problem"],
["8","8","37","M","Single","Low","1","2046.88","7","17","Online
Banking","Unresolved"],
["9","8","37","M","Single","Low","1","2046.88","7","17","Online
Banking","Unresolved"],
["10","9","39","M","Divorced","High","0","1317.24","5","24","Website",
"Resolved"],
["11","10","68","M","Married","High","1","1397.36","7","29","Online
Banking","No Problem"],
["12","11","54","M","Divorced","Medium","0","1733.83","5","30","Online
Banking","Resolved"],
["13","11","54","M","Divorced","Medium","0","1733.83","5","30","Online
Banking","Unresolved"],
["14","12","41","F","Married","Low","0","87.1","1","43","Website","Res
olved"],
["15","12","41","F","Married","Low","0","87.1","1","43","Website","Unr
esolved"],
["16","13","24","F","Divorced","Low","0","392.02","3","10","Mobile
App","Resolved"],
["17","14","42","M","Widowed","Medium","0","2843.59","9","26","Online
Banking","Unresolved"],
["18","14","42","M","Widowed","Medium","0","2843.59","9","26","Online
Banking","Resolved"],
["19","15","42","M","Divorced","Medium","0","1914.02","8","44","Online
Banking","Unresolved"],
["20","15","42","M","Divorced","Medium","0","1914.02","8","44","Online
Banking","Unresolved"],
["21","16","30","F","Single","Medium","1","2019.79","9","41","Online
Banking","Resolved"],
["22","16","30","F","Single","Medium","1","2019.79","9","41","Online
Banking","Resolved"],
["23","17","19","M","Married","Low","0","1625.27","7","8","Online
Banking","Unresolved"],
["24","17","19","M","Married","Low","0","1625.27","7","8","Online
Banking","Resolved"],
["25","18","56","F","Married","High","1","951.3800000000001","5","37",
"Website","Unresolved"],
["26","19","57","F","Divorced","High","0","1017.26","5","39","Online
Banking","Unresolved"],
["27","19","57","F","Divorced","High","0","1017.26","5","39","Online
Banking","Unresolved"],
["28","20","41","M","Single","Low","0","2775.85","9","16","Website","R
esolved"],
["29","21","64","M","Divorced","High","0","913.02","5","18","Website",
"No Problem"],
["30","22","42","F","Divorced","Low","0","1582.73","6","42","Mobile
App","Resolved"],
["31","22","42","F","Divorced","Low","0","1582.73","6","42","Mobile
App","Resolved"],
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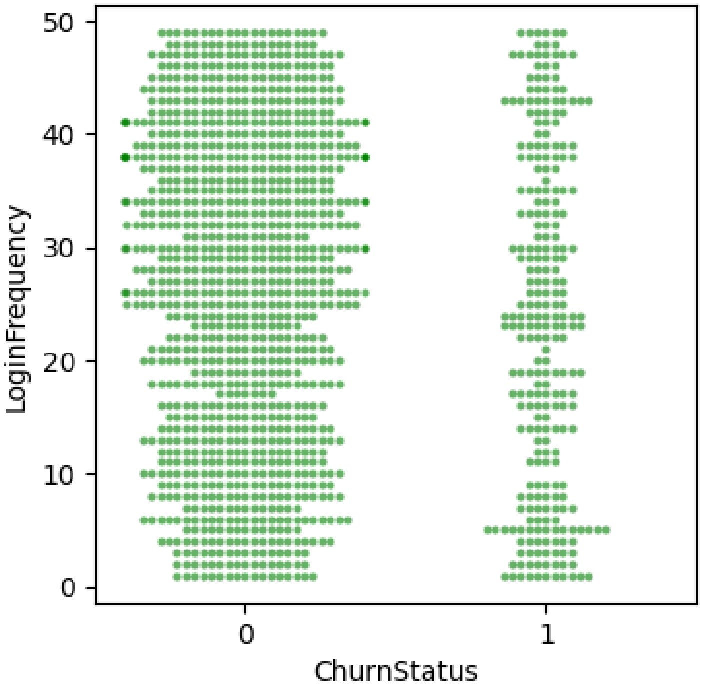
App","Unresolved"],
["33","23","35","F","Divorced","Low","0","1490.74","4","19","Mobile
App","Resolved"],
["34","24","55","M","Widowed","Medium","0","1143.22","5","12","Mobile
App","Resolved"],
["35","25","43","F","Married","Low","0","764.77","3","27","Mobile
App","Resolved"],
["36","26","31","M","Single","Medium","1","571.76","3","45","Mobile
App","Resolved"],
["37","27","26","M","Widowed","Medium","0","2210.6","8","22","Mobile
App","Unresolved"],
["38","28","27","F","Widowed","High","0","1702.26","6","42","Online
Banking","Unresolved"],
["39","28","27","F","Widowed","High","0","1702.26","6","42","Online
Banking","Unresolved"],
["40","29","38","F","Divorced","Medium","0","853.0699999999999","3","3
4","Website","Resolved"],
["41","29","38","F","Divorced","Medium","0","853.0699999999999","3","3
4","Website","Unresolved"],
["42","30","69","M","Divorced","High","0","706.66","2","38","Website",
"Resolved"],
["43","30","69","M","Divorced","High","0","706.66","2","38","Website",
"Unresolved"],
["44","31","34","M","Divorced","Low","0","1108.56","5","23","Online
Banking","Resolved"],
["45","31","34","M","Divorced","Low","0","1108.56","5","23","Online
Banking","Resolved"],
["46","32","69","F","Married","High","0","1225.52","5","48","Mobile
App","No Problem"],
["47","33","23","M","Divorced","High","1","689.0","2","24","Mobile
App","Resolved"],
["48","34","33","M","Widowed","High","0","1886.4","9","44","Online
Banking","Resolved"],
["49","34","33","M","Widowed","High","0","1886.4","9","44","Online
Banking","Unresolved"]],"shape":{"columns":11,"rows":1334}}
```

```
# churn status  vs incoem level
df_final.columns
```

```
Index(['CustomerID', 'Age', 'Gender', 'MaritalStatus', 'IncomeLevel',
       'ChurnStatus', 'total_amount', 'countoftransaction',
'LoginFrequency',
       'ServiceUsage', 'ResolutionStatus'],
      dtype='object')
```

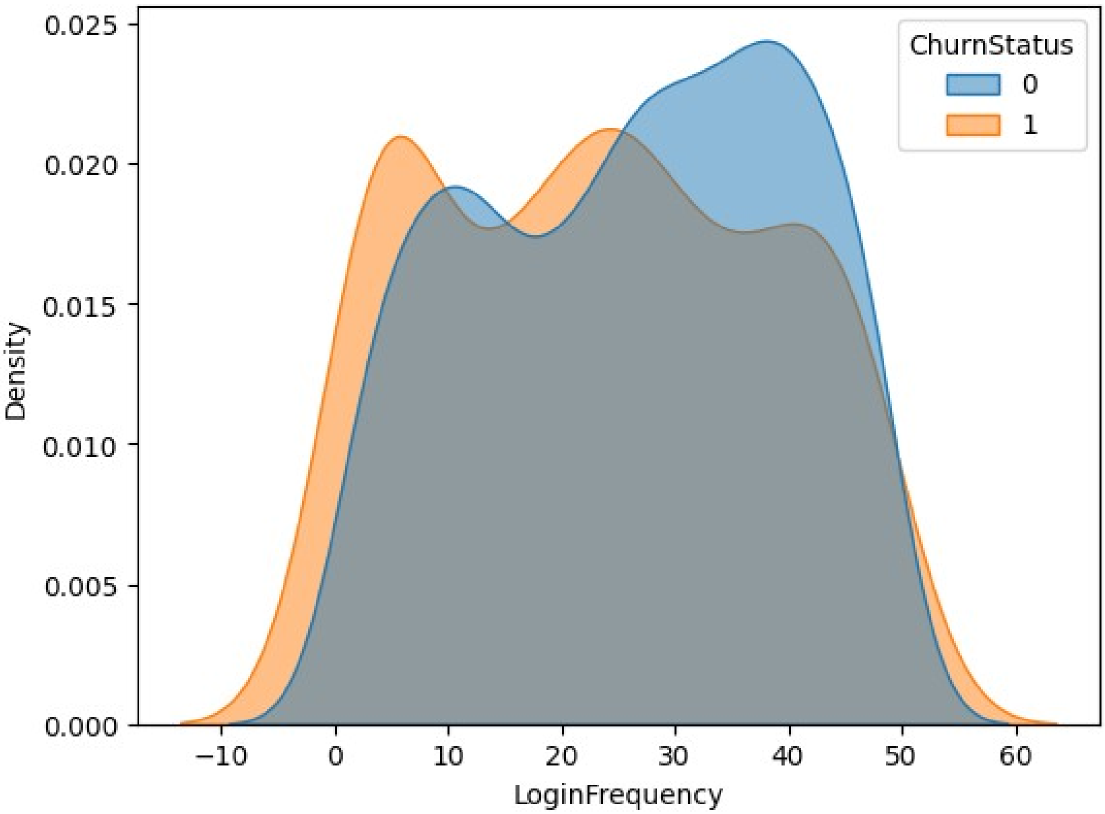
```
plt.figure( figsize= ( 4 , 4 ))
sns.swarmplot(x='ChurnStatus', y='LoginFrequency', data=df_final,
color='g', size=3, alpha=0.6)
# people with t=less login frequency are leaving
```

```
<Axes: xlabel='ChurnStatus', ylabel='LoginFrequency'>
```



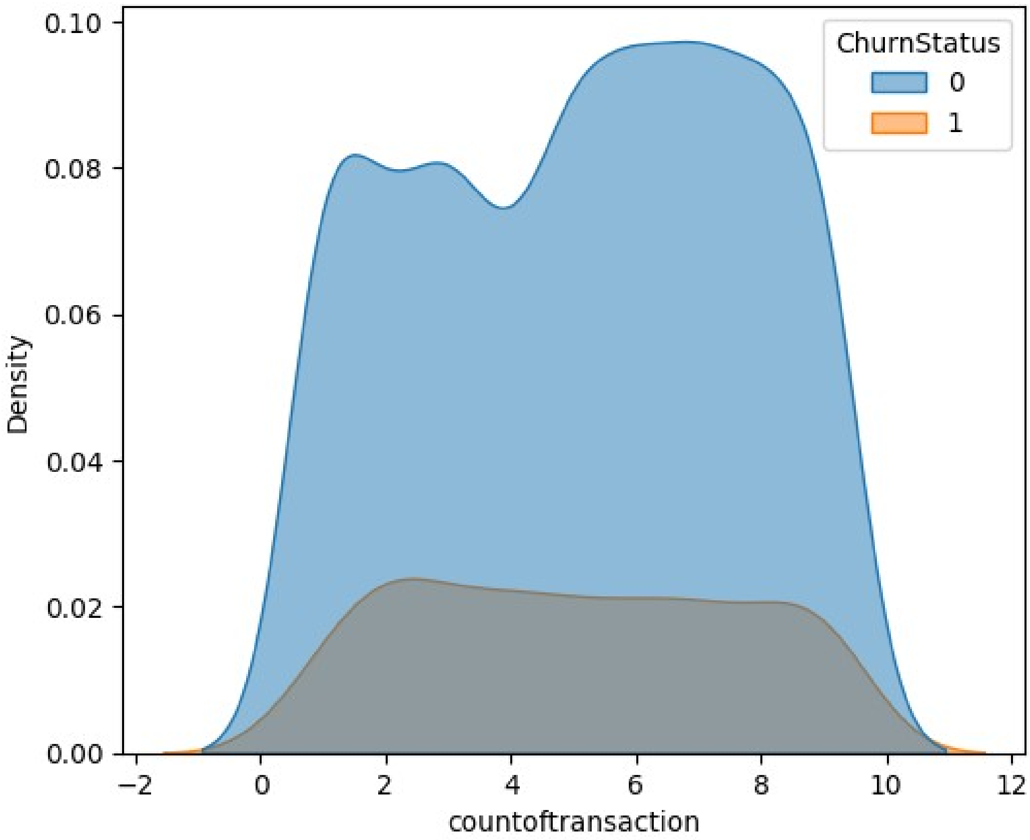
```
sns.kdeplot(data=df_final, x='LoginFrequency', hue='ChurnStatus',
fill=True, common_norm=False, alpha=0.5)
```

```
<Axes: xlabel='LoginFrequency', ylabel='Density'>
```



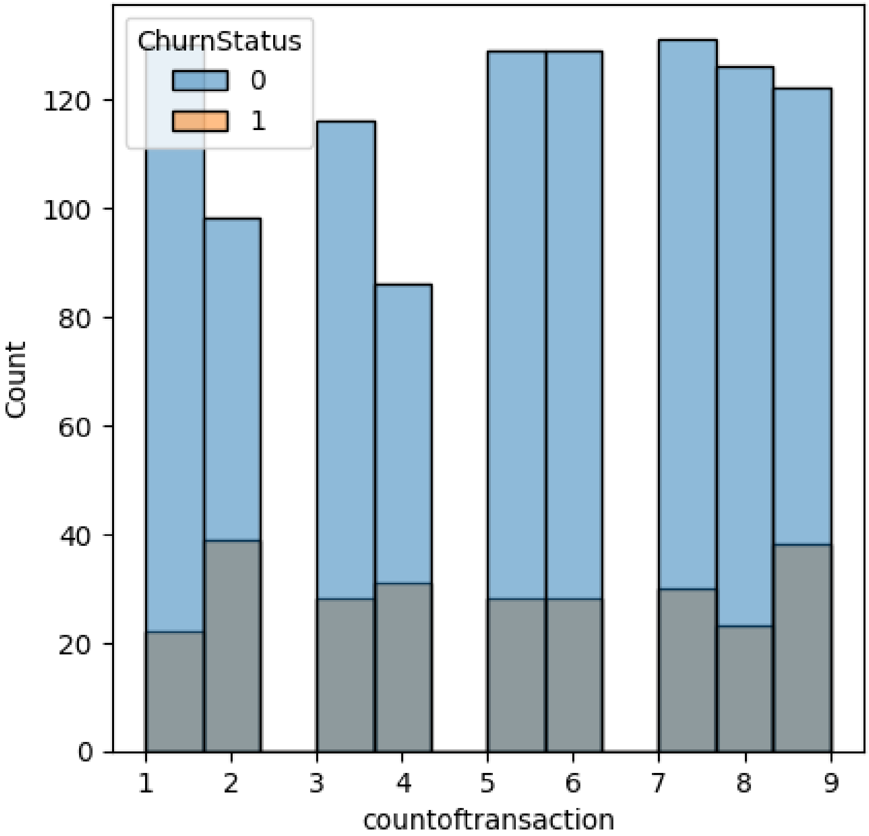
```
plt.figure( figsize = ( 6 , 5 ))
sns.kdeplot( data = df_final ,  x = 'countoftransaction'  , hue =
'ChurnStatus'  ,  fill = True , alpha = 0.5 )
```

```
<Axes: xlabel='countoftransaction', ylabel='Density'>
```



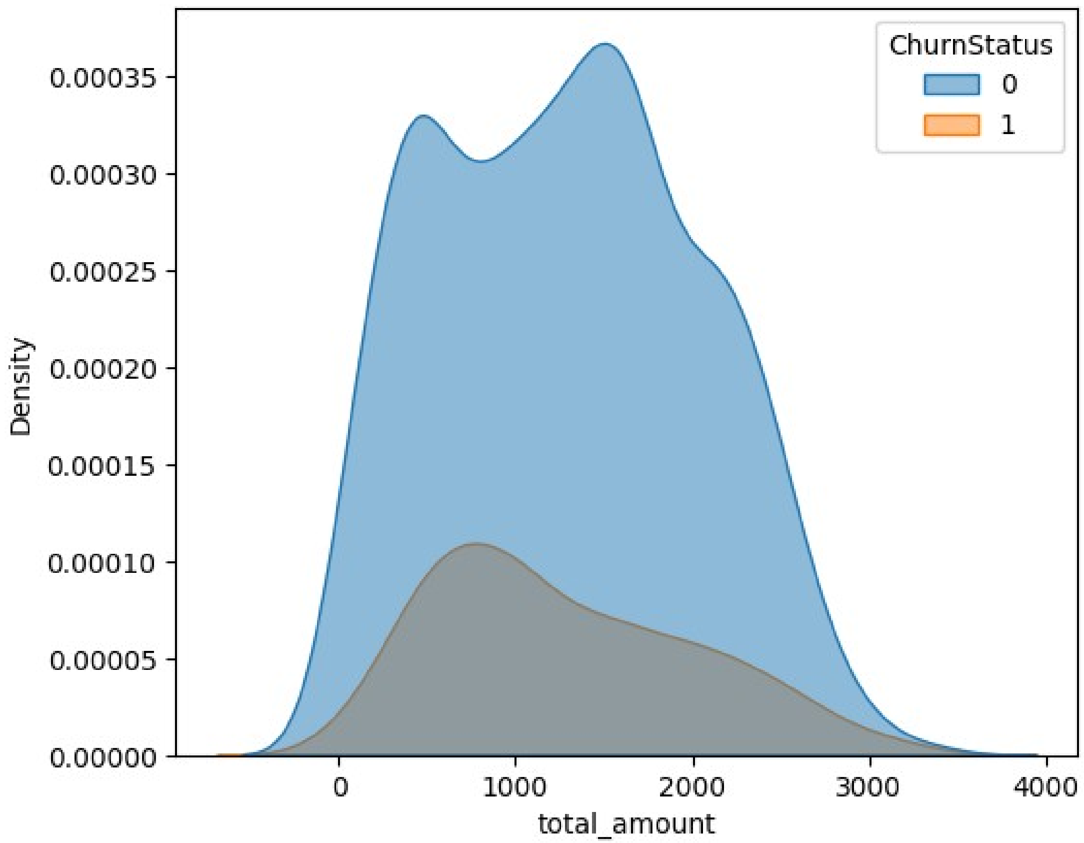
```
plt.figure( figsize = ( 5 , 5 ))
sns.histplot( data = df_final ,  x = 'countoftransaction'  , hue =
'ChurnStatus'  ,  fill = True , alpha = 0.5 )

<Axes: xlabel='countoftransaction', ylabel='Count'>
```



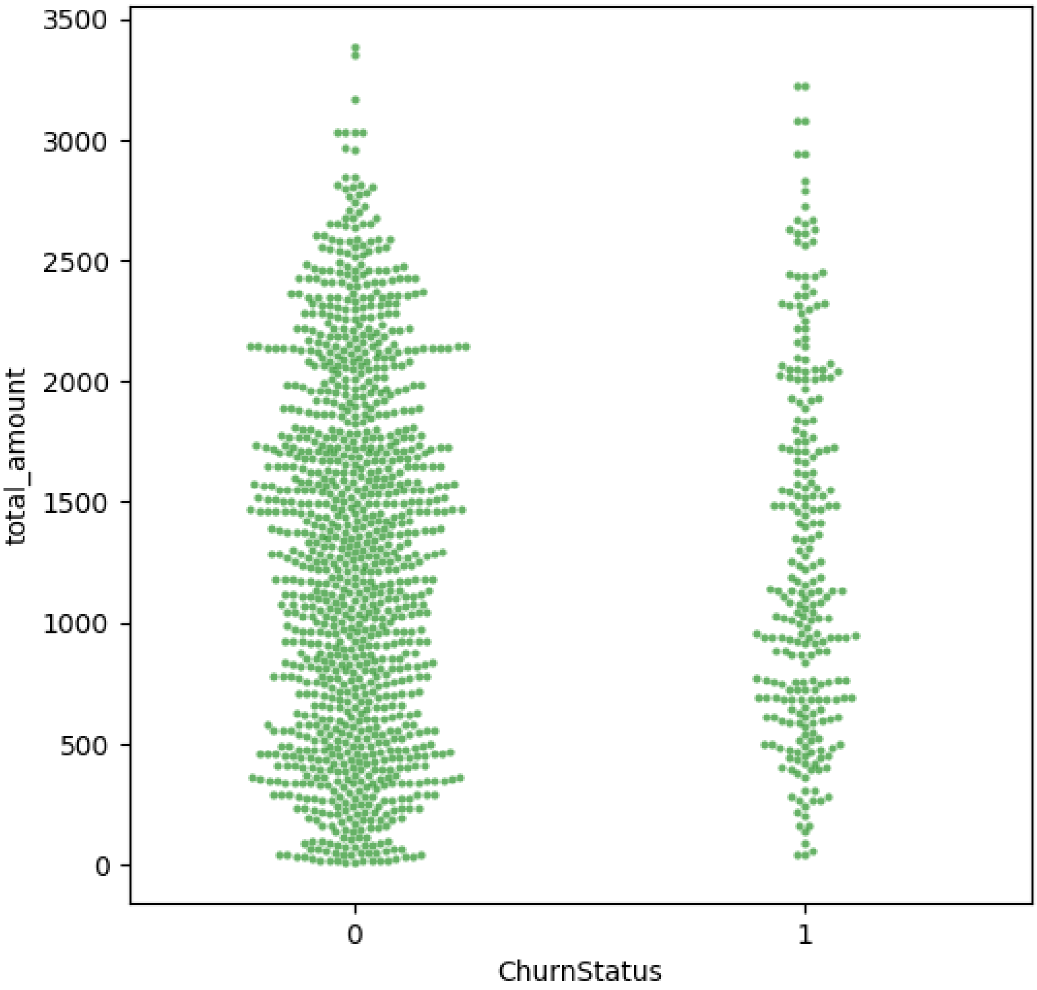
```
plt.figure( figsize = ( 6 , 5 ))
sns.kdeplot( data = df_final ,  x = 'total_amount'  , hue =
'ChurnStatus'  ,  fill = True , alpha = 0.5 )

<Axes: xlabel='total_amount', ylabel='Density'>
```



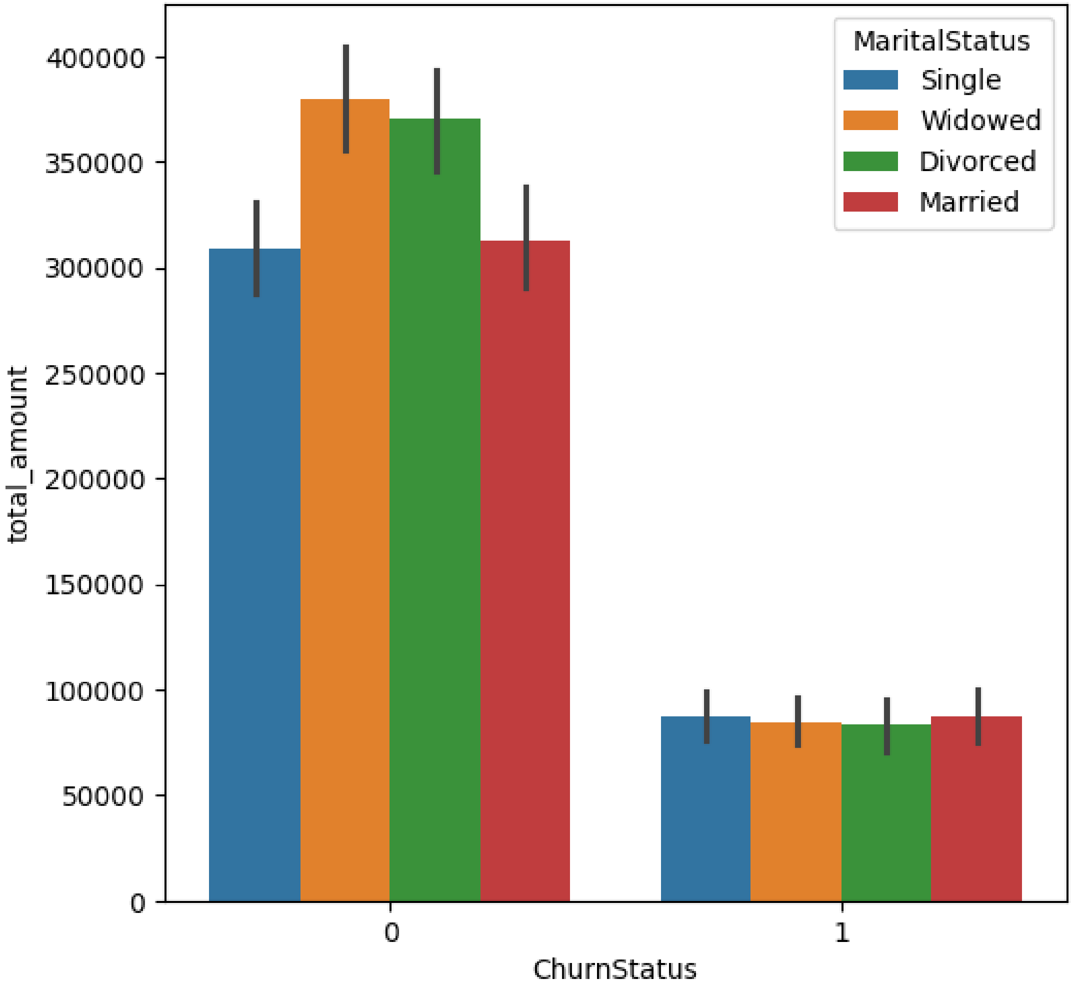
```
plt.figure( figsize= ( 6 , 6 ))
sns.swarmplot(x='ChurnStatus', y='total_amount', data=df_final,
color='g', size=3, alpha=0.6)

<Axes: xlabel='ChurnStatus', ylabel='total_amount'>
```



```
plt.figure( figsize= ( 6 , 6 ))
sns.barplot( data = df_final ,  x =  'ChurnStatus'  , y =
'total_amount'  , hue = 'MaritalStatus' , estimator = sum )
```

```
<Axes: xlabel='ChurnStatus', ylabel='total_amount'>
```

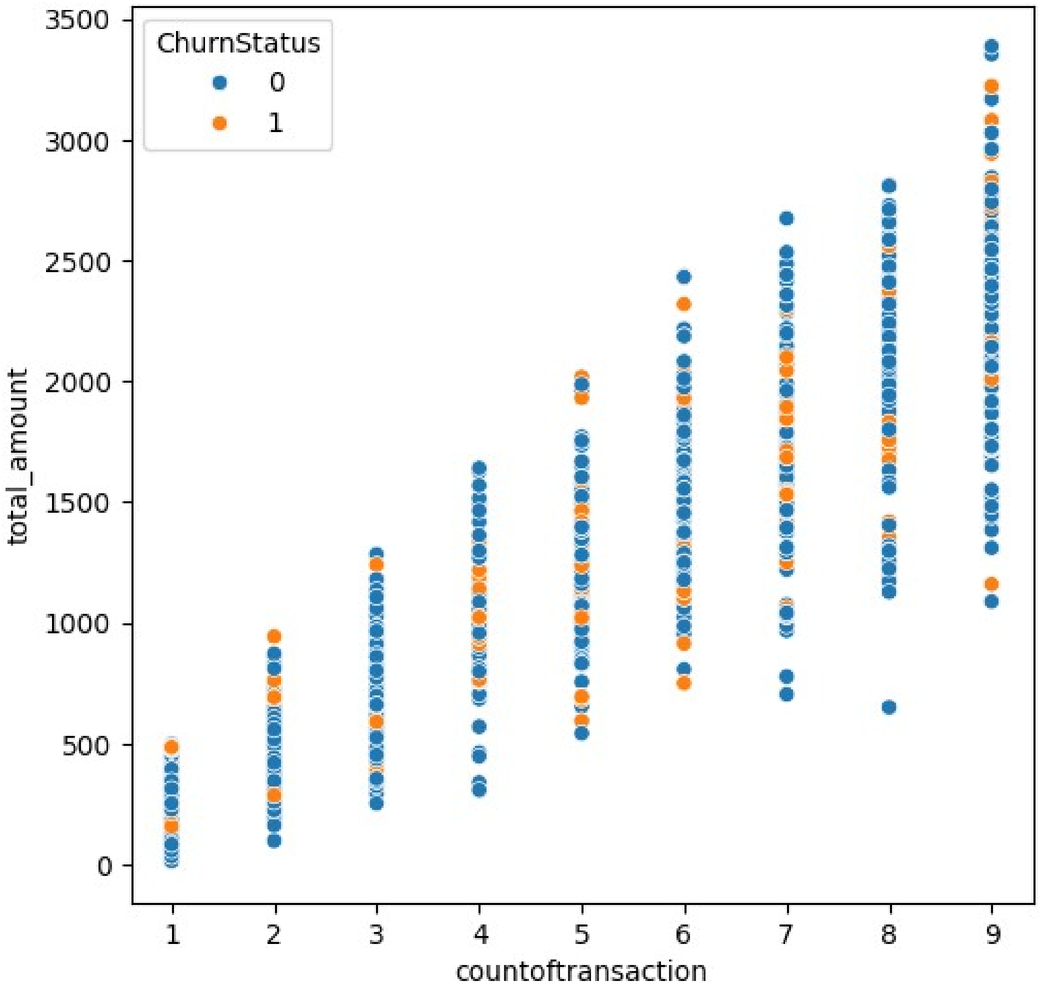


```
'''['CustomerID', 'Age', 'Gender', 'MaritalStatus', 'IncomeLevel',
       'ChurnStatus', 'total_amount', 'countoftransaction',
'LoginFrequency',
       'ServiceUsage', 'ResolutionStatus'] '''
```

```
"['CustomerID', 'Age', 'Gender', 'MaritalStatus', 'IncomeLevel',\n
'ChurnStatus', 'total_amount', 'countoftransaction',
'LoginFrequency',\n       'ServiceUsage', 'ResolutionStatus'] "
```

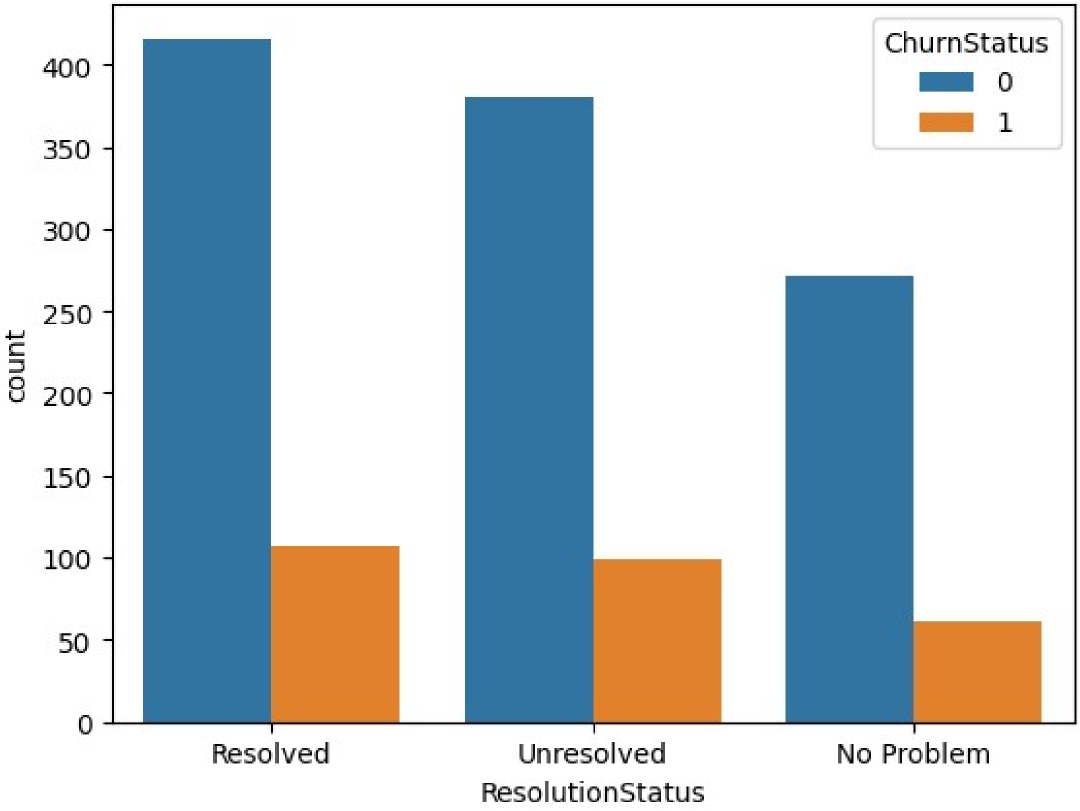
```
plt.figure( figsize= ( 6 , 6 ))
sns.scatterplot( data = df_final ,  x =  'countoftransaction' , y =
'total_amount'  , hue = 'ChurnStatus' )
```

```
<Axes: xlabel='countoftransaction', ylabel='total_amount'>
```



```
sns.countplot(data=df_final , x = 'ResolutionStatus',  hue =
'ChurnStatus' )
```

```
<Axes: xlabel='ResolutionStatus', ylabel='count'>
```



```
django = pd.crosstab( df_final['ResolutionStatus'] ,
df_final['ChurnStatus'] )

django
```

{"columns":
[{"name":"ResolutionStatus","rawType":"object","type":"string"},
{"name":"0","rawType":"int64","type":"integer"},
{"name":"1","rawType":"int64","type":"integer"}],"ref":"5f20da98-7336-4109-a3d8-587773110858","rows":[["No Problem","271","61"],
["Resolved","416","107"],["Unresolved","380","99"]],"shape":
{"columns":2,"rows":3}}

```
django_normal = django.div( django.sum(axis= 1 )  , axis = 0 )

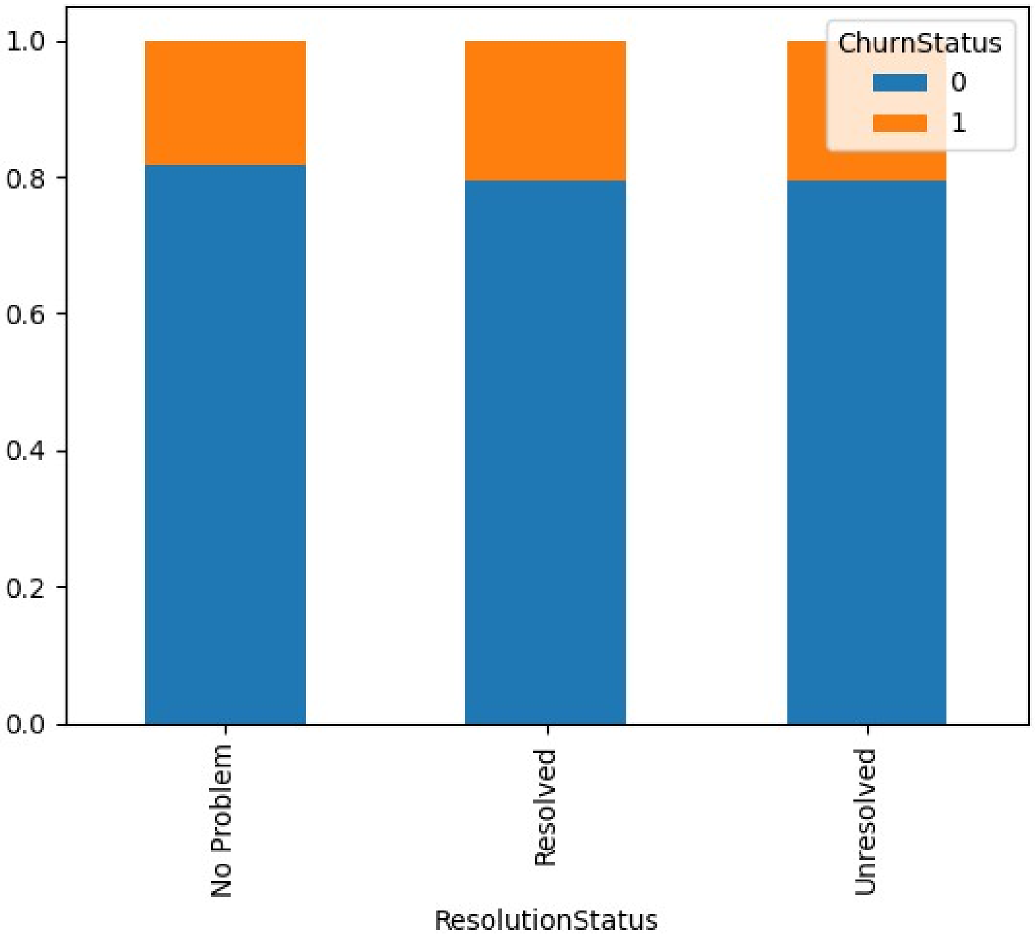
django_normal
```

{"columns":
[{"name":"ResolutionStatus","rawType":"object","type":"string"},
{"name":"0","rawType":"float64","type":"float"},
{"name":"1","rawType":"float64","type":"float"}],"ref":"571962d8-4590-4020-88e9-554ef9ca1878","rows":[["No
Problem","0.8162650602409639","0.18373493975903615"],
["Resolved","0.7954110898661568","0.2045889101338432"],

```
["Unresolved","0.7933194154488518","0.20668058455114824"]],"shape":
{"columns":2,"rows":3}}
```

```
django_normal.plot( kind = 'bar'  , stacked = True )
```

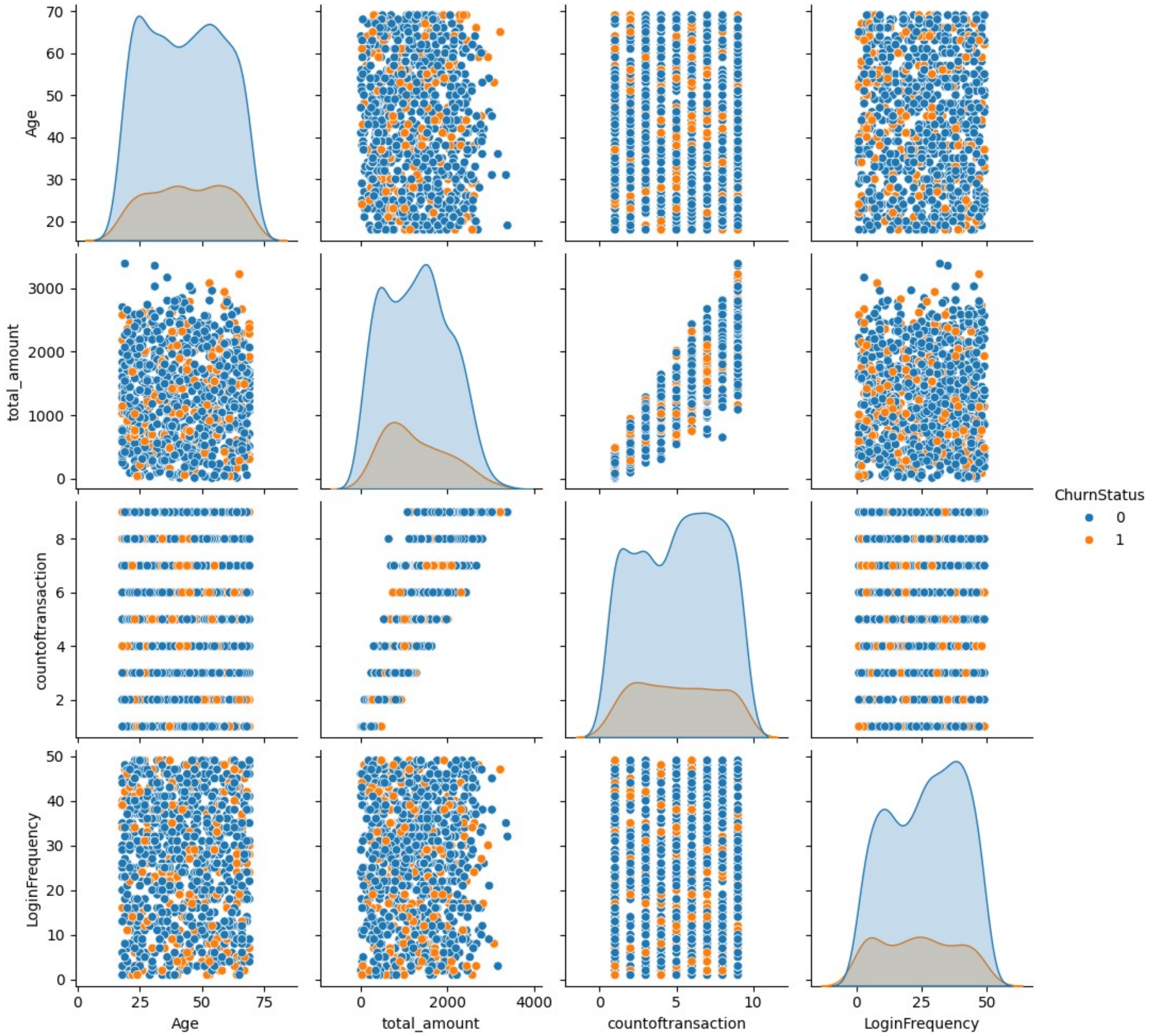
```
<Axes: xlabel='ResolutionStatus'>
```



```
numeric_cols = [
    'Age', 'total_amount', 'countoftransaction',
    'LoginFrequency'
]

sns.pairplot(df_final[numeric_cols + ['ChurnStatus']],
hue='ChurnStatus')
```

```
<seaborn.axisgrid.PairGrid at 0x24475408710>
```



```
palette = {0: 'blue', 1: 'red'}

plt.figure(figsize=(10, 6))
scatter = plt.scatter(
    df_final['Age'] ,
    df_final['total_amount'],
    s=df_final['LoginFrequency'] * 10,  # Adjust multiplier for
visible bubble sizes
    c=df_final['ChurnStatus'].map(palette),
    alpha=0.6,
    edgecolors='w',
    linewidth=0.5
)

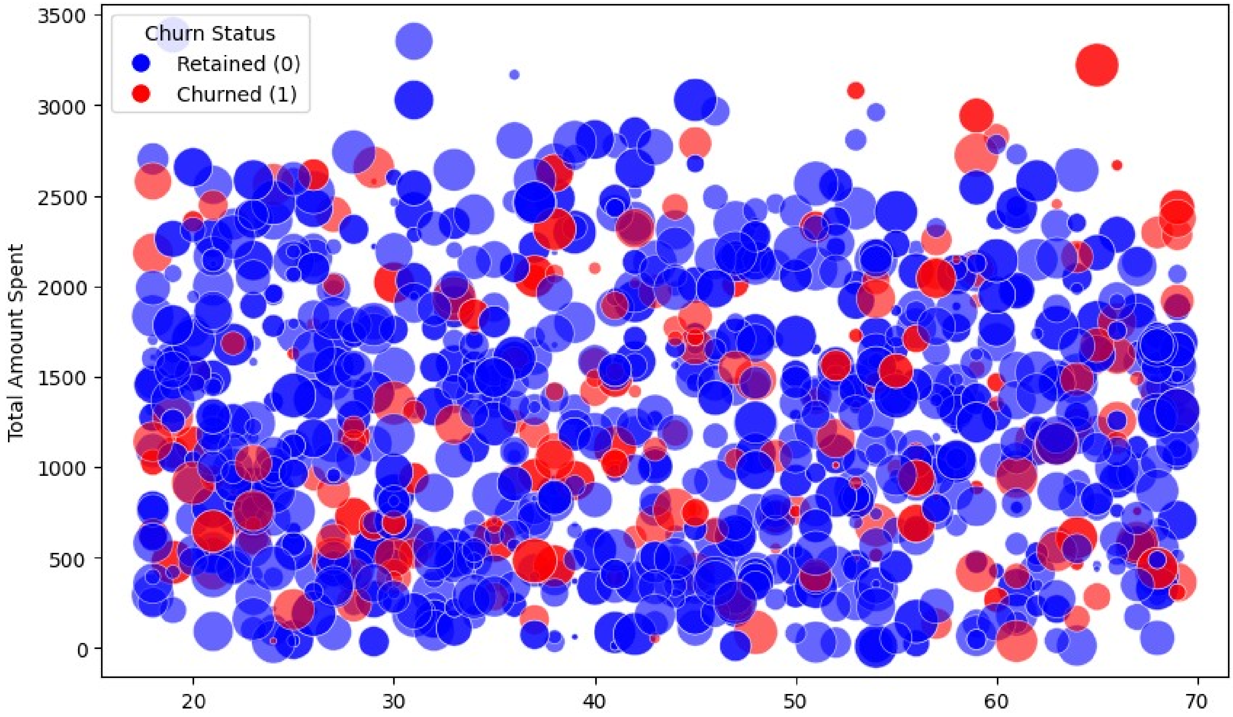
# Custom legend for ChurnStatus
```

```
from matplotlib.lines import Line2D
legend_elements = [
    Line2D([0], [0], marker='o', color='w', label='Retained (0)',
markerfacecolor='blue', markersize=10),
    Line2D([0], [0], marker='o', color='w', label='Churned (1)',
markerfacecolor='red', markersize=10)
]

plt.legend(handles=legend_elements, title="Churn Status")
plt.ylabel('Total Amount Spent')

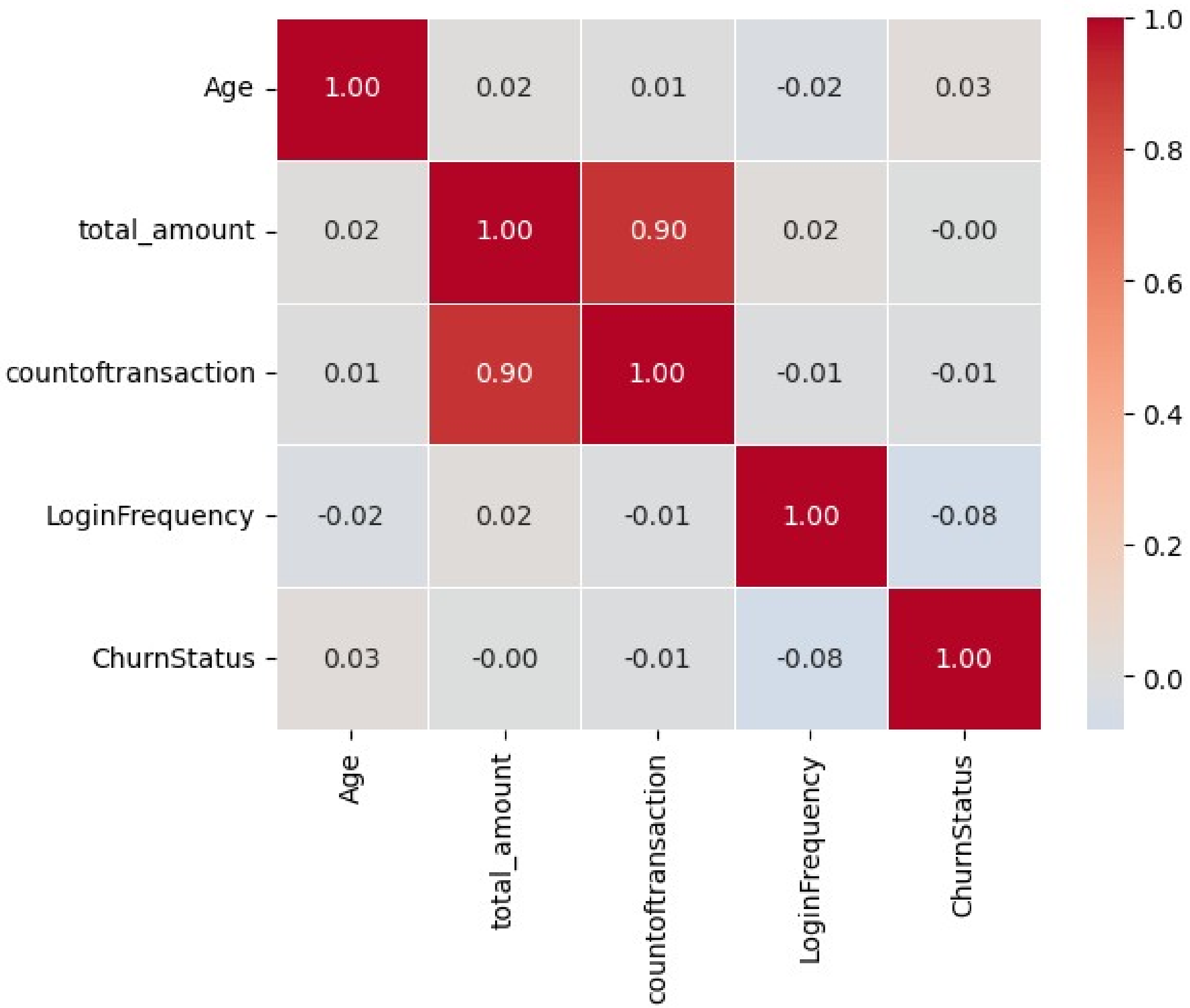
# we are losing low spending young customers
```

```
Text(0, 0.5, 'Total Amount Spent')
```



```
corr_matrix = df_final[numeric_cols +
['ChurnStatus']].corr(method='pearson')
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', center=0,
linewidths=.5, fmt=".2f")
```

```
<Axes: >
```



```
from scipy.stats import pointbiserialr

# List your numeric columns

correlations = {}
for col in numeric_cols:
    corr, _ = pointbiserialr(df_final['ChurnStatus'], df_final[col])
    correlations[col] = corr

# Convert to DataFrame for plotting
corr_df = pd.DataFrame(list(correlations.items()),
columns=['Variable', 'PointBiserialCorrelation'])
corr_df = corr_df.sort_values('PointBiserialCorrelation', key=abs,
ascending=False)

corr_df
```

{"columns":[{"name":"index","rawType":"int64","type":"integer"},
{"name":"Variable","rawType":"object","type":"string"},

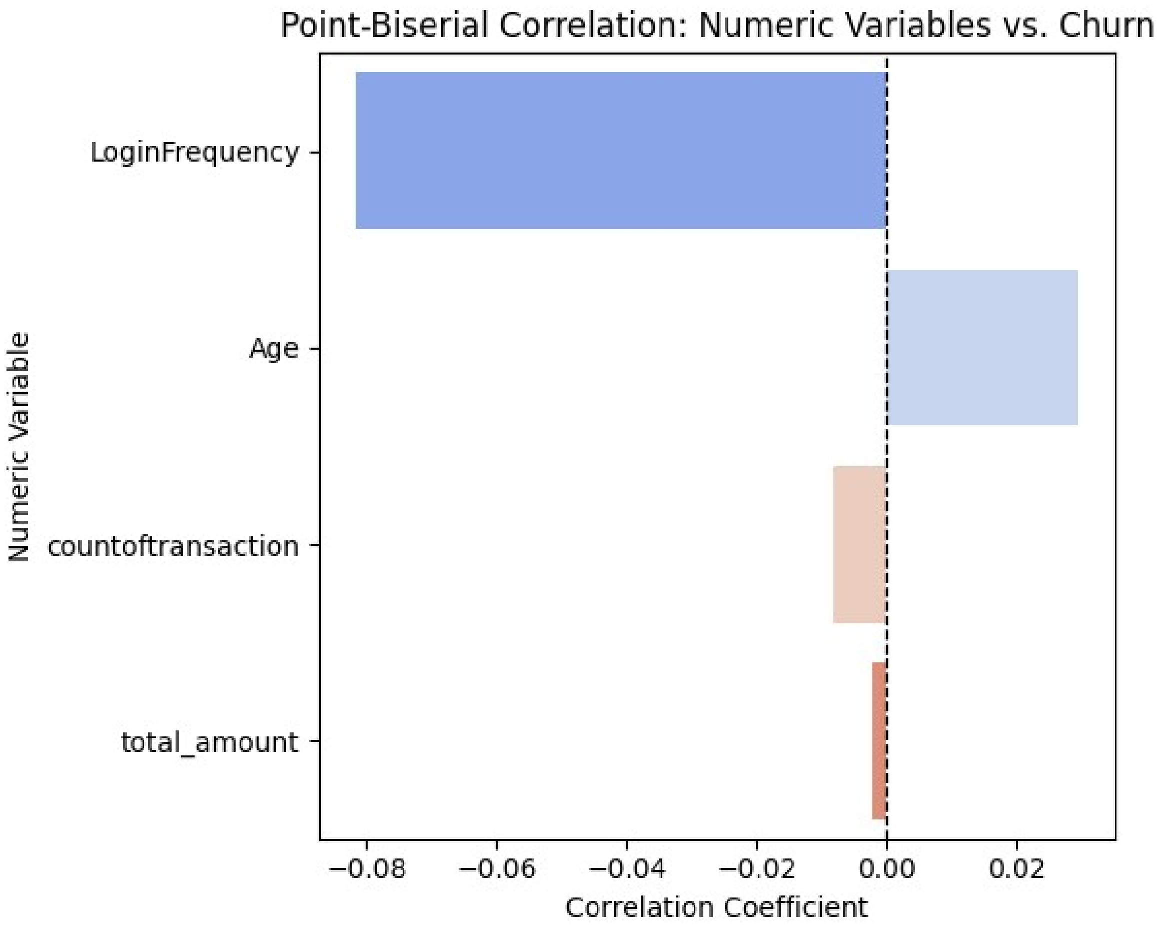
```
{"name":"PointBiserialCorrelation","rawType":"float64","type":"float"}
],"ref":"9b7acbc7-d71f-4274-9d9a-55ddb8f06d6d","rows":
[["3","LoginFrequency","-0.08159047725998914"],
["0","Age","0.029585983696895548"],["2","countoftransaction","-
0.00821776456349772"],["1","total_amount","-
0.0022439614369999823"]],"shape":{"columns":2,"rows":4}}
```

```python
plt.figure(figsize=(6, 5))
sns.barplot(
    data=corr_df,
    x='PointBiserialCorrelation',
    y='Variable',
    palette='coolwarm',
    orient='h'
)
plt.title('Point-Biserial Correlation: Numeric Variables vs. Churn')
plt.xlabel('Correlation Coefficient')
plt.ylabel('Numeric Variable')
plt.axvline(0, color='k', linestyle='--', linewidth=1)
plt.tight_layout()
plt.show()
```

```
C:\Users\Ayush\AppData\Local\Temp\ipykernel_3312\1030485422.py:2:
FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be
removed in v0.14.0. Assign the `y` variable to `hue` and set
`legend=False` for the same effect.

  sns.barplot(
```



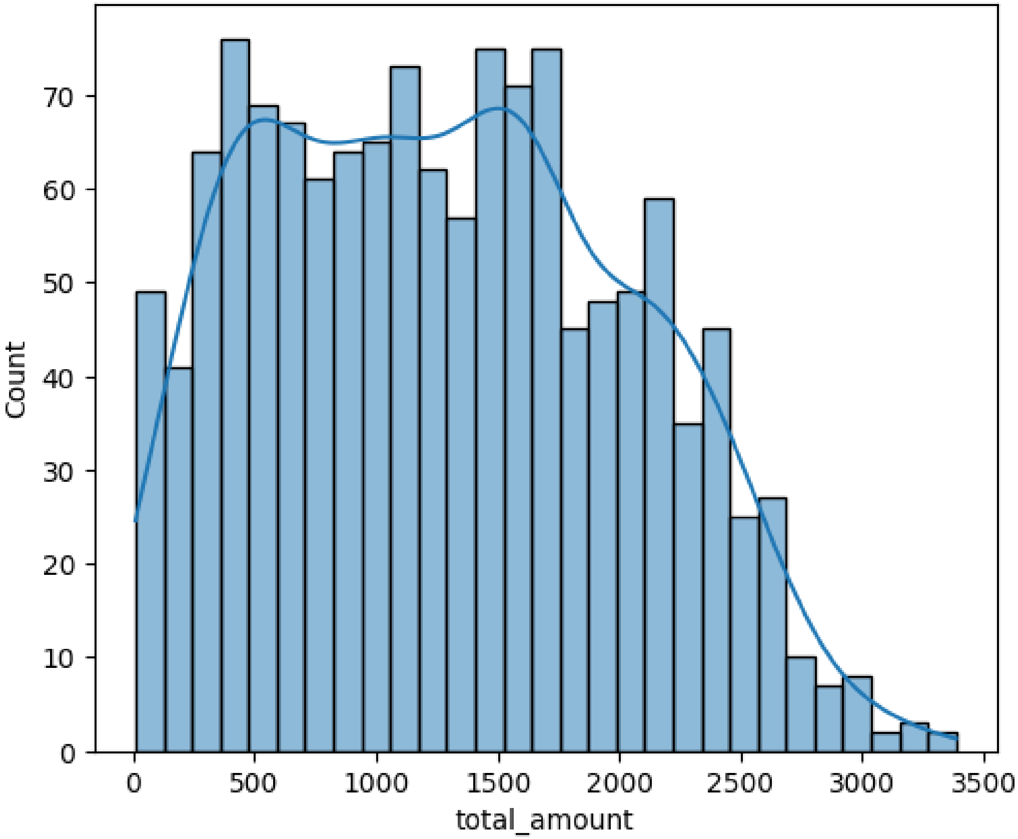
```
df_final.columns
```

```
Index(['CustomerID', 'Age', 'Gender', 'MaritalStatus', 'IncomeLevel',
       'ChurnStatus', 'total_amount', 'countoftransaction',
'LoginFrequency',
       'ServiceUsage', 'ResolutionStatus'],
      dtype='object')
```

outliers , imputing etc

```
plt.figure(figsize=(6, 5))
sns.histplot( data = df_final  , x ='total_amount' , bins = 29 , kde=
True )
```

```
<Axes: xlabel='total_amount', ylabel='Count'>
```

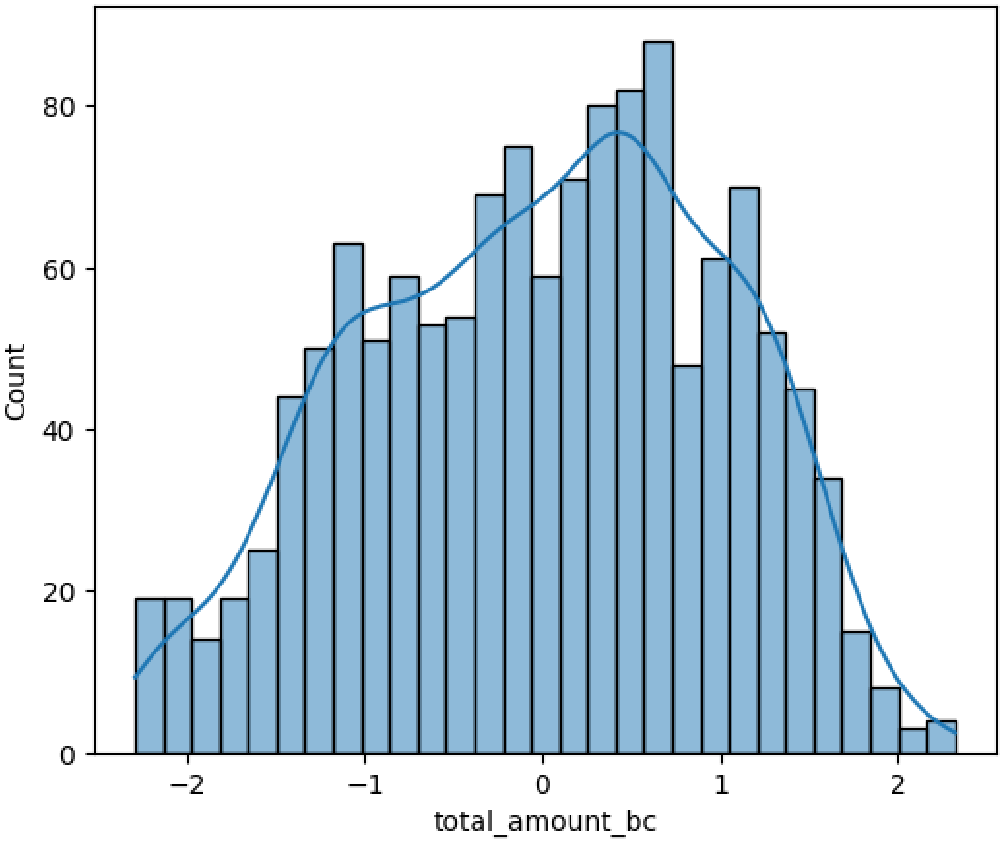


```python
from sklearn.preprocessing import PowerTransformer

# For strictly positive data (Box-Cox)
pt = PowerTransformer(method='box-cox')
df_final['total_amount_bc'] =
pt.fit_transform(df_final[['total_amount']])

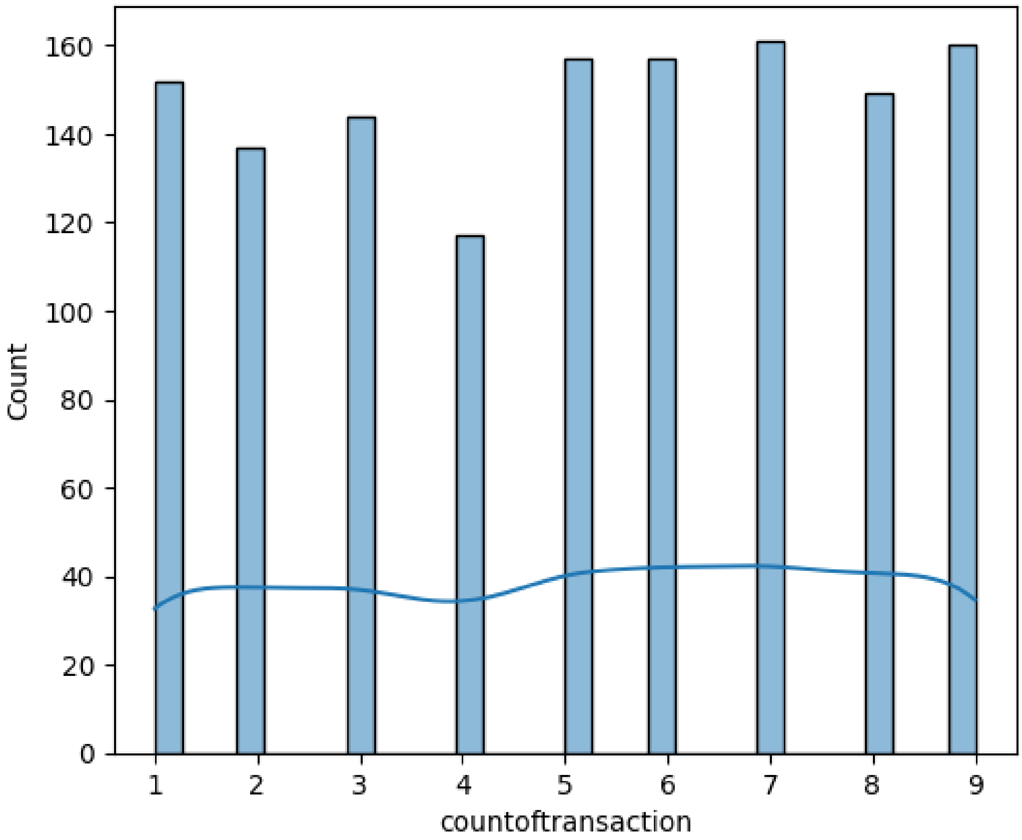
plt.figure(figsize=(6, 5))
sns.histplot( data = df_final  , x ='total_amount_bc' , bins = 29 ,
kde= True )
```

```
<Axes: xlabel='total_amount_bc', ylabel='Count'>
```



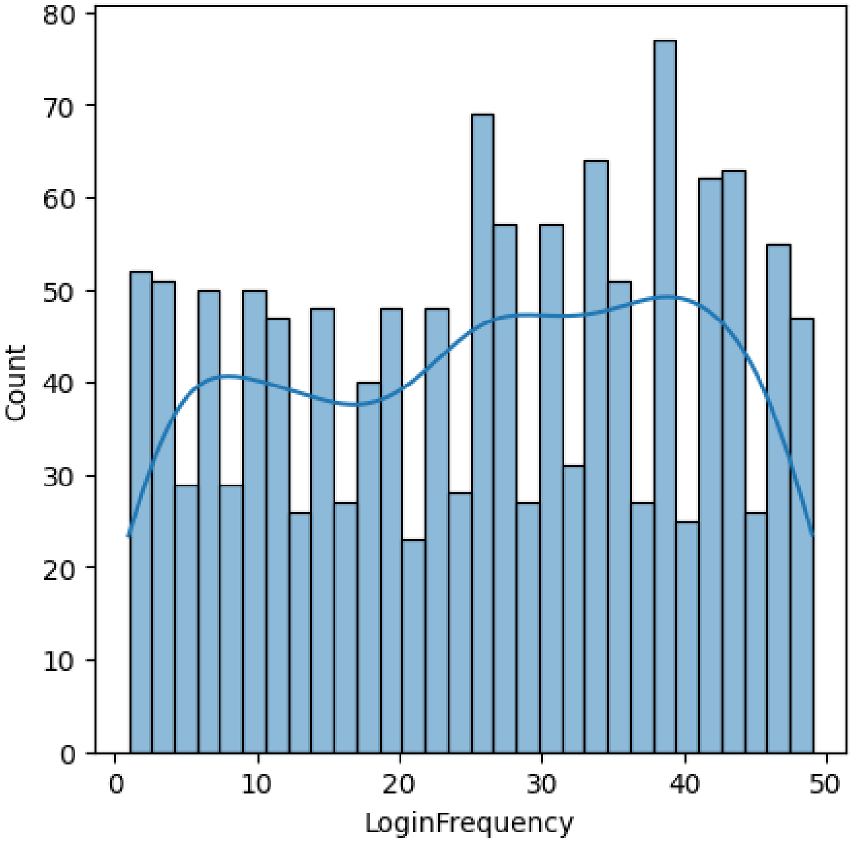
```
plt.figure(figsize=(6, 5))
sns.histplot( data = df_final  , x ='countoftransaction' , bins = 30,
kde= True )
```

```
<Axes: xlabel='countoftransaction', ylabel='Count'>
```



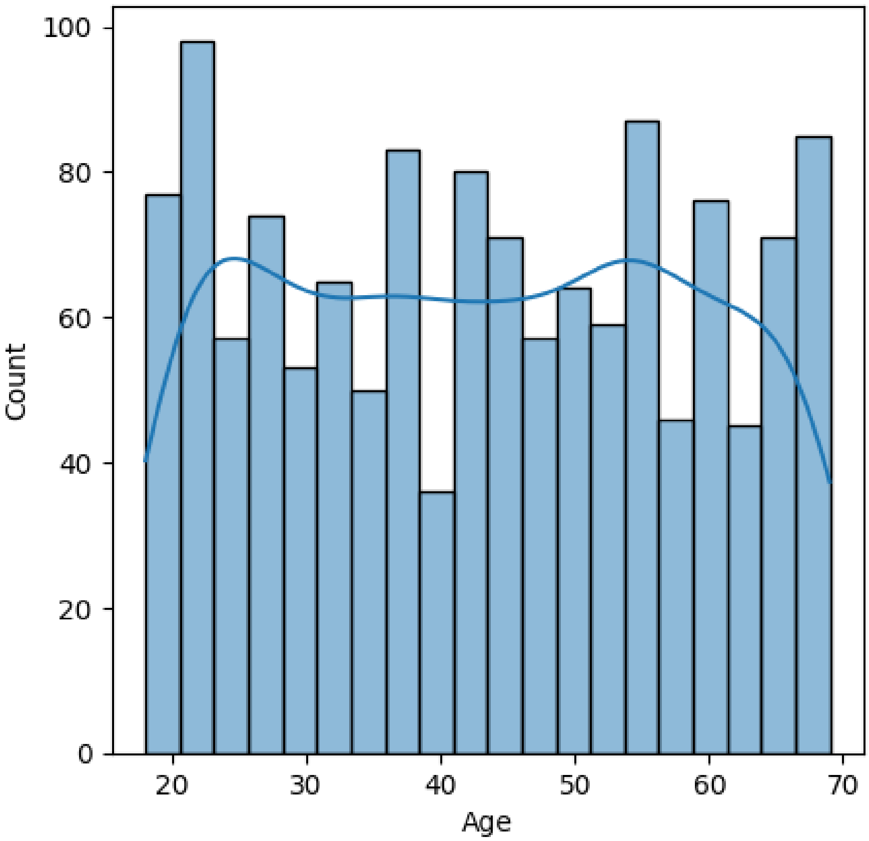
```
plt.figure(figsize=(5, 5))
sns.histplot( data = df_final  , x ='LoginFrequency' , bins = 30, kde=
True )

<Axes: xlabel='LoginFrequency', ylabel='Count'>
```



```
plt.figure(figsize=(5, 5))
sns.histplot( data = df_final  , x ='Age' , bins = 20, kde= True )

<Axes: xlabel='Age', ylabel='Count'>
```



```
from scipy.stats import zscore

# List your numeric columns
numeric_cols = [
     'total_amount', 'countoftransaction',
    'LoginFrequency'
]

outlier_results = {}

for col in numeric_cols:
    data = pd.to_numeric(df_final[col], errors='coerce').dropna()
    # IQR Method
    Q1 = data.quantile(0.25)
    Q3 = data.quantile(0.75)
    IQR = Q3 - Q1
    lower_bound = Q1 - 1.5 * IQR
    upper_bound = Q3 + 1.5 * IQR
    iqr_outliers = (data < lower_bound) | (data > upper_bound)

    # Z-score Method
    z_scores = zscore(data)
    z_outliers = np.abs(z_scores) > 3
    # Combine outlier indices
    outlier_indices_iqr = data.index[iqr_outliers].tolist()
    outlier_indices_z = data.index[z_outliers].tolist()

    outlier_results[col] = {
        'iqr_outlier_indices': outlier_indices_iqr,
        'zscore_outlier_indices': outlier_indices_z,
        'num_iqr_outliers': len(outlier_indices_iqr),
        'num_zscore_outliers': len(outlier_indices_z),
    }
    print(f"{col} - IQR: {len(outlier_indices_iqr)} outliers, Z-score:
{len(outlier_indices_z)} outliers")

# Example: To view outlier rows for a specific column using IQR
# df_final.loc[outlier_results['total_amount']['iqr_outlier_indices']]
```

```
total_amount - IQR: 0 outliers, Z-score: 0 outliers
countoftransaction - IQR: 0 outliers, Z-score: 0 outliers
LoginFrequency - IQR: 0 outliers, Z-score: 0 outliers
```

```
df_final.drop( columns= ['total_amount_log'] , inplace= True )
```

```
df_final
```

```
{"columns":[{"name":"index","rawType":"int64","type":"integer"},
{"name":"CustomerID","rawType":"int64","type":"integer"},
{"name":"Age","rawType":"int64","type":"integer"},
{"name":"Gender","rawType":"object","type":"string"},
{"name":"MaritalStatus","rawType":"object","type":"string"},
{"name":"IncomeLevel","rawType":"object","type":"string"},
{"name":"ChurnStatus","rawType":"int64","type":"integer"},
{"name":"total_amount","rawType":"float64","type":"float"},
{"name":"countoftransaction","rawType":"int64","type":"integer"},
{"name":"LoginFrequency","rawType":"int64","type":"integer"},
{"name":"ServiceUsage","rawType":"object","type":"string"},
{"name":"ResolutionStatus","rawType":"object","type":"string"},
{"name":"total_amount_bc","rawType":"float64","type":"float"}],"ref":"
33547094-0303-4369-bc76-1c6b00344b6e","rows":
[["0","1","62","M","Single","Low","0","416.5","1","34","Mobile
App","Resolved","-1.1901642609199812"],
["1","2","65","M","Married","Low","1","1547.4199999999998","7","5","We
bsite","Resolved","0.43822023200276483"],
["2","3","18","M","Single","Low","0","1702.98","6","3","Website","Reso
lved","0.6206325962206389"],
["3","4","21","M","Widowed","Low","0","917.29","5","2","Website","Reso
lved","-0.3796921171977037"],
["4","4","21","M","Widowed","Low","0","917.29","5","2","Website","Unre
solved","-0.3796921171977037"],
["5","5","21","M","Divorced","Medium","0","2001.49","8","41","Website"
,"No Problem","0.9551734421229886"],
["6","6","57","F","Divorced","Medium","0","1164.29","5","2","Website",
"Resolved","-0.041026979273344984"],
["7","7","27","F","Married","High","0","86.73","1","32","Mobile
App","No Problem","-1.961883066701129"],
["8","8","37","M","Single","Low","1","2046.88","7","17","Online
Banking","Unresolved","1.0044663399625502"],
["9","8","37","M","Single","Low","1","2046.88","7","17","Online
Banking","Unresolved","1.0044663399625502"],
["10","9","39","M","Divorced","High","0","1317.24","5","24","Website",
"Resolved","0.15605453836881017"],
["11","10","68","M","Married","High","1","1397.36","7","29","Online
Banking","No Problem","0.25608631618162225"],
["12","11","54","M","Divorced","Medium","0","1733.83","5","30","Online
Banking","Resolved","0.656104788648745"],
["13","11","54","M","Divorced","Medium","0","1733.83","5","30","Online
Banking","Unresolved","0.656104788648745"],
["14","12","41","F","Married","Low","0","87.1","1","43","Website","Res
olved","-1.9606782443744375"],
["15","12","41","F","Married","Low","0","87.1","1","43","Website","Unr
esolved","-1.9606782443744375"],
["16","13","24","F","Divorced","Low","0","392.02","3","10","Mobile
App","Resolved","-1.2367978100623787"],
["17","14","42","M","Widowed","Medium","0","2843.59","9","26","Online
Banking","Unresolved","1.8161825611228544"],
["18","14","42","M","Widowed","Medium","0","2843.59","9","26","Online
Banking","Resolved","1.8161825611228544"],
["19","15","42","M","Divorced","Medium","0","1914.02","8","44","Online
Banking","Unresolved","0.8590672945046037"],
["20","15","42","M","Divorced","Medium","0","1914.02","8","44","Online
Banking","Unresolved","0.8590672945046037"],
["21","16","30","F","Single","Medium","1","2019.79","9","41","Online
Banking","Resolved","0.9750934186066263"],
["22","16","30","F","Single","Medium","1","2019.79","9","41","Online
Banking","Resolved","0.9750934186066263"],
["23","17","19","M","Married","Low","0","1625.27","7","8","Online
Banking","Unresolved","0.5302701236774611"],
["24","17","19","M","Married","Low","0","1625.27","7","8","Online
Banking","Resolved","0.5302701236774611"],
["25","18","56","F","Married","High","1","951.3800000000001","5","37",
"Website","Unresolved","-0.3312106037377801"],
["26","19","57","F","Divorced","High","0","1017.26","5","39","Online
Banking","Unresolved","-0.23920075300576915"],
["27","19","57","F","Divorced","High","0","1017.26","5","39","Online
Banking","Unresolved","-0.23920075300576915"],
["28","20","41","M","Single","Low","0","2775.85","9","16","Website","R
esolved","1.7505691628647226"],
["29","21","64","M","Divorced","High","0","913.02","5","18","Website",
"No Problem","-0.38580868952859837"],
["30","22","42","F","Divorced","Low","0","1582.73","6","42","Mobile
App","Resolved","0.4801662949072248"],
["31","22","42","F","Divorced","Low","0","1582.73","6","42","Mobile
App","Resolved","0.4801662949072248"],
["32","23","35","F","Divorced","Low","0","1490.74","4","19","Mobile
App","Unresolved","0.3701825145092396"],
["33","23","35","F","Divorced","Low","0","1490.74","4","19","Mobile
App","Resolved","0.3701825145092396"],
["34","24","55","M","Widowed","Medium","0","1143.22","5","12","Mobile
App","Resolved","-0.06886566901905382"],
["35","25","43","F","Married","Low","0","764.77","3","27","Mobile
App","Resolved","-0.6048482455780341"],
["36","26","31","M","Single","Medium","1","571.76","3","45","Mobile
App","Resolved","-0.9138823188174997"],
["37","27","26","M","Widowed","Medium","0","2210.6","8","22","Mobile
App","Unresolved","1.179186215571774"],
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```
cols_to_scale = ['Age', 'total_amount_bc', 'LoginFrequency',
'countoftransaction']

scaler = StandardScaler()
x_scaled = scaler.fit_transform( df_final[cols_to_scale])
```

```
xsdf = pd.DataFrame( x_scaled  , columns= [ col +'_scaled'  for col in
cols_to_scale ] , index = df_final.index )

xsdf
```

```
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```

```
df_final = pd.concat([df_final, xsdf], axis=1 )

df_final.drop( columns = cols_to_scale +['total_amount']  , inplace=
True )

df_final
```

```
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```
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```
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```

```python
cat_cols = ['Gender' , 'MaritalStatus'  ,'IncomeLevel' ,
'ServiceUsage' ,'ResolutionStatus'   ]

dummies = pd.get_dummies( df_final[cat_cols]  , prefix= 'cat_')


df_final = pd.concat( [df_final ,dummies]  , axis =1 )

df_final.drop( columns=cat_cols , inplace=True )
```