```python
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt

import scipy.stats as stats
# Load the dataset
df = pd.read_csv("/content/UCI_Credit_Card.csv")
```

```python
# Display the first few rows of the dataset
print(df.head())
```

```
   ID  LIMIT_BAL  SEX  EDUCATION  MARRIAGE  AGE  PAY_0  PAY_2  PAY_3  PAY_4  \
0   1    20000.0    2          2         1   24      2      2     -1     -1
1   2   120000.0    2          2         2   26     -1      2      0      0
2   3    90000.0    2          2         2   34      0      0      0      0
3   4    50000.0    2          2         1   37      0      0      0      0
4   5    50000.0    1          2         1   57     -1      0     -1      0

   ...  BILL_AMT4  BILL_AMT5  BILL_AMT6  PAY_AMT1  PAY_AMT2  PAY_AMT3  \
0  ...        0.0        0.0        0.0       0.0     689.0       0.0
1  ...     3272.0     3455.0     3261.0       0.0    1000.0    1000.0
2  ...    14331.0    14948.0    15549.0    1518.0    1500.0    1000.0
3  ...    28314.0    28959.0    29547.0    2000.0    2019.0    1200.0
4  ...    20940.0    19146.0    19131.0    2000.0   36681.0   10000.0

   PAY_AMT4  PAY_AMT5  PAY_AMT6  default.payment.next.month
0       0.0       0.0       0.0                           1
1    1000.0       0.0    2000.0                           1
2    1000.0    1000.0    5000.0                           0
3    1100.0    1069.0    1000.0                           0
4    9000.0     689.0     679.0                           0

[5 rows x 25 columns]
```

```python
# Basic statistics of numerical columns
print(df.describe())
```

```
                 ID      LIMIT_BAL           SEX     EDUCATION      MARRIAGE  \
count  30000.000000   30000.000000  30000.000000  30000.000000  30000.000000
mean   15000.500000  167484.322667      1.603733      1.853133      1.551867
std     8660.398374  129747.661567      0.489129      0.790349      0.521970
min        1.000000   10000.000000      1.000000      0.000000      0.000000
25%     7500.750000   50000.000000      1.000000      1.000000      1.000000
50%    15000.500000  140000.000000      2.000000      2.000000      2.000000
75%    22500.250000  240000.000000      2.000000      2.000000      2.000000
max    30000.000000 1000000.000000      2.000000      6.000000      3.000000

                AGE         PAY_0         PAY_2         PAY_3         PAY_4  \
count  30000.000000  30000.000000  30000.000000  30000.000000  30000.000000
mean      35.485500     -0.016700     -0.133767     -0.166200     -0.220667
std        9.217904      1.123802      1.197186      1.196868      1.169139
min       21.000000     -2.000000     -2.000000     -2.000000     -2.000000
25%       28.000000     -1.000000     -1.000000     -1.000000     -1.000000
50%       34.000000      0.000000      0.000000      0.000000      0.000000
75%       41.000000      0.000000      0.000000      0.000000      0.000000
max       79.000000      8.000000      8.000000      8.000000      8.000000

          ...     BILL_AMT4     BILL_AMT5     BILL_AMT6      PAY_AMT1  \
count     ...  30000.000000  30000.000000  30000.000000  30000.000000
mean      ...  43262.948967  40311.400967  38871.760400   5663.580500
std       ...  64332.856134  60797.155770  59554.107537  16563.280354
min       ... -170000.000000 -81334.000000 -339603.000000      0.000000
25%       ...   2326.750000   1763.000000   1256.000000   1000.000000
50%       ...  19052.000000  18104.500000  17071.000000   2100.000000
75%       ...  54506.000000  50190.500000  49198.250000   5006.000000
max       ... 891586.000000 927171.000000 961664.000000 873552.000000

           PAY_AMT2      PAY_AMT3      PAY_AMT4      PAY_AMT5  \
count  3.000000e+04  30000.00000  30000.000000  30000.000000
mean   5.921163e+03   5225.68150   4826.076867   4799.387633
std    2.304087e+04  17606.96147  15666.159744  15278.305679
min    0.000000e+00      0.00000      0.000000      0.000000
25%    8.330000e+02    390.00000    296.000000    252.500000
50%    2.009000e+03   1800.00000   1500.000000   1500.000000
```

```
75%     5.000000e+03     4505.00000   4013.250000    4031.500000
max     1.684259e+06   896040.00000  621000.000000  426529.000000

             PAY_AMT6   default.payment.next.month
count   30000.000000                 30000.000000
mean     5215.502567                     0.221200
std     17777.465775                     0.415062
min         0.000000                     0.000000
25%       117.750000                     0.000000
50%      1500.000000                     0.000000
75%      4000.000000                     0.000000
max    528666.000000                     1.000000

[8 rows x 25 columns]
```

```python
# Check for missing values
print(df.isnull().sum())
```

```
ID                            0
LIMIT_BAL                     0
SEX                           0
EDUCATION                     0
MARRIAGE                      0
AGE                           0
PAY_0                         0
PAY_2                         0
PAY_3                         0
PAY_4                         0
PAY_5                         0
PAY_6                         0
BILL_AMT1                     0
BILL_AMT2                     0
BILL_AMT3                     0
BILL_AMT4                     0
BILL_AMT5                     0
BILL_AMT6                     0
PAY_AMT1                      0
PAY_AMT2                      0
PAY_AMT3                      0
PAY_AMT4                      0
PAY_AMT5                      0
PAY_AMT6                      0
default.payment.next.month    0
dtype: int64
```

```python
output = 'default.payment.next.month'
```

```python
# EDA
cols = [ f for f in df.columns if df.dtypes[ f ] != "object"]
cols.remove( "ID")
cols.remove( output )

f = pd.melt( df, id_vars=output, value_vars=cols)
g = sns.FacetGrid( f, hue=output, col="variable", col_wrap=5, sharex=False, sharey=False )
g = g.map( sns.distplot, "value", kde=True).add_legend()
```

```
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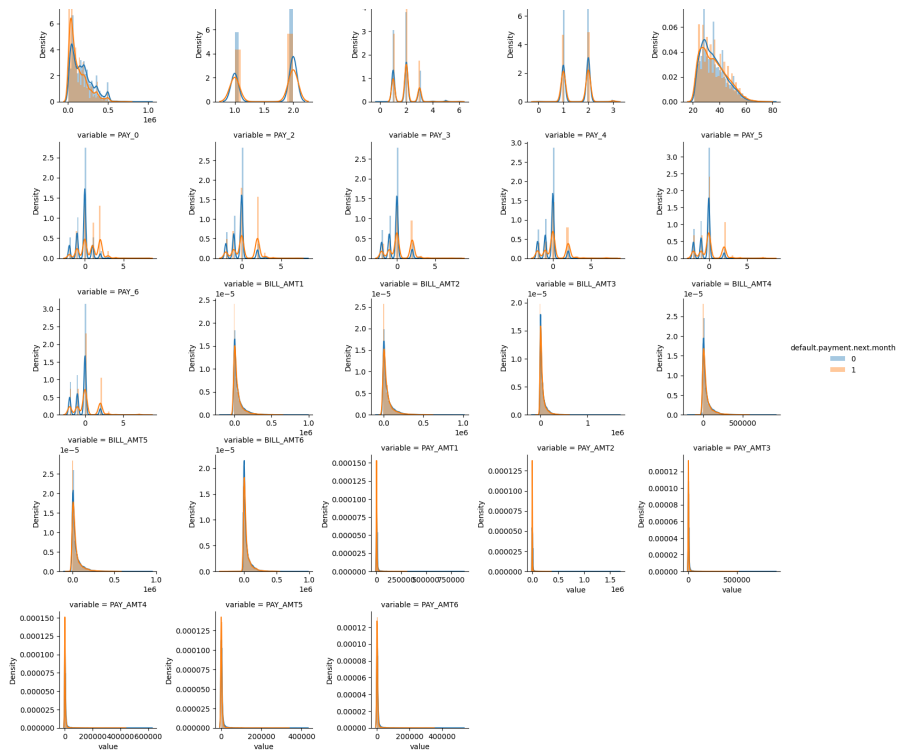similar flexibility) or `histplot` (an axes-level function for histograms).

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```python
def ChiSquaredTestOfIndependence( df, inputVar, Outcome_Category ):
    Outcome_Category_Table = df.groupby( Outcome_Category )[ Outcome_Category ].count().values
    Outcome_Category_Ratios = Outcome_Category_Table / sum( Outcome_Category_Table )
    possibleVals = df[inputVar].unique()
    observed = []
    expected = []
    for possible in possibleVals:
        countsInCategories = df[ df[ inputVar ] == possible ].groupby( Outcome_Category )[Outcome_Category].count().values
        if( len(countsInCategories) != len( Outcome_Category_Ratios ) ):
            print("Error! The class " + str( possible) +" of \'" + inputVar + "\' does not contain all values of \'" + Outcome_Category + "\
            return
        elif( min(countsInCategories) < 5 ):
            print("Chi Squared Test needs at least 5 observations in each cell!")
            print( inputVar + "=" + str(possible) + " has insufficient data")
            print( countsInCategories )
            return
        else:
            observed.append( countsInCategories )
            expected.append( Outcome_Category_Ratios * len( df[df[ inputVar ] == possible ]))
    observed = np.array( observed )
    expected = np.array( expected )
    chi_squared_stat = ((observed - expected)**2 / expected).sum().sum()
    degOfF = (observed.shape[0] - 1 ) *(observed.shape[1] - 1 )
    #crit = stats.chi2.ppf(q = 0.95,df = degOfF)
    p_value = 1 - stats.chi2.cdf(x=chi_squared_stat, df=degOfF)
    print("Calculated test-statistic is %.2f" % chi_squared_stat )
    print("If " + Outcome_Category + " is indep of " + inputVar + ", this has prob %.2e of occurring" % p_value )


ChiSquaredTestOfIndependence( df, "SEX", output )
```

```
    Calculated test-statistic is 47.91
    If default.payment.next.month is indep of SEX, this has prob 4.47e-12 of occurring
```

```python
ChiSquaredTestOfIndependence( df, "EDUCATION", output )
```

```
    Error! The class 0 of 'EDUCATION' does not contain all values of 'default.payment.next.month'
```

```python
print("We have %d with EDUCATION=0" % len(df.loc[ df["EDUCATION"]==0]))
print("We have %d with EDUCATION=4" % len(df.loc[ df["EDUCATION"]==4]))
print("We have %d with EDUCATION=5" % len(df.loc[ df["EDUCATION"]==5]))
print("We have %d with EDUCATION=6" % len(df.loc[ df["EDUCATION"]==6]))
```

```
    We have 14 with EDUCATION=0
    We have 123 with EDUCATION=4
    We have 280 with EDUCATION=5
    We have 51 with EDUCATION=6
```

```python
df["EDUCATION_Corr"] = df["EDUCATION"].apply( lambda x: x if ((x>0) and (x<4)) else 4 )
ChiSquaredTestOfIndependence( df, "EDUCATION_Corr", output )
cols.remove("EDUCATION")
cols.append("EDUCATION_Corr")

ChiSquaredTestOfIndependence( df, "MARRIAGE", output )
```

```
    Calculated test-statistic is 160.41
    If default.payment.next.month is indep of EDUCATION_Corr, this has prob 0.00e+00 of occurring
    Calculated test-statistic is 35.66
    If default.payment.next.month is indep of MARRIAGE, this has prob 8.83e-08 of occurring
```

```
logged = []
for ii in range(1,7):
    qual_Enc.remove("PAY_AMT" + str( ii ))
    df[ "log_PAY_AMT" + str( ii )]  = df["PAY_AMT"  + str( ii )].apply( lambda x: np.log1p(x) if (x>0) else 0 )
    logged.append("log_PAY_AMT" + str( ii ) )


for ii in range(1,7):
    qual_Enc.remove("BILL_AMT" + str( ii ))
    df[ "log_BILL_AMT" + str( ii )] = df["BILL_AMT" + str( ii )].apply( lambda x: np.log1p(x) if (x>0) else 0 )
    logged.append("log_BILL_AMT" + str( ii ) )


f = pd.melt( df, id_vars=output, value_vars=logged)
g = sns.FacetGrid( f, hue=output, col="variable", col_wrap=3, sharex=False, sharey=False )
g = g.map( sns.distplot, "value", kde=True).add_legend()
```

```
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