```
import numpy as np
import pandas as pd

df = pd.read_csv('/content/Churn_Modelling.csv')

#univariate analysis-1)summary statistics

df['Balance'].mean()
```

```
76485.889288
```

```
df['Age'].median()
```

```
37.0
```

```
df['CreditScore'].std()
```

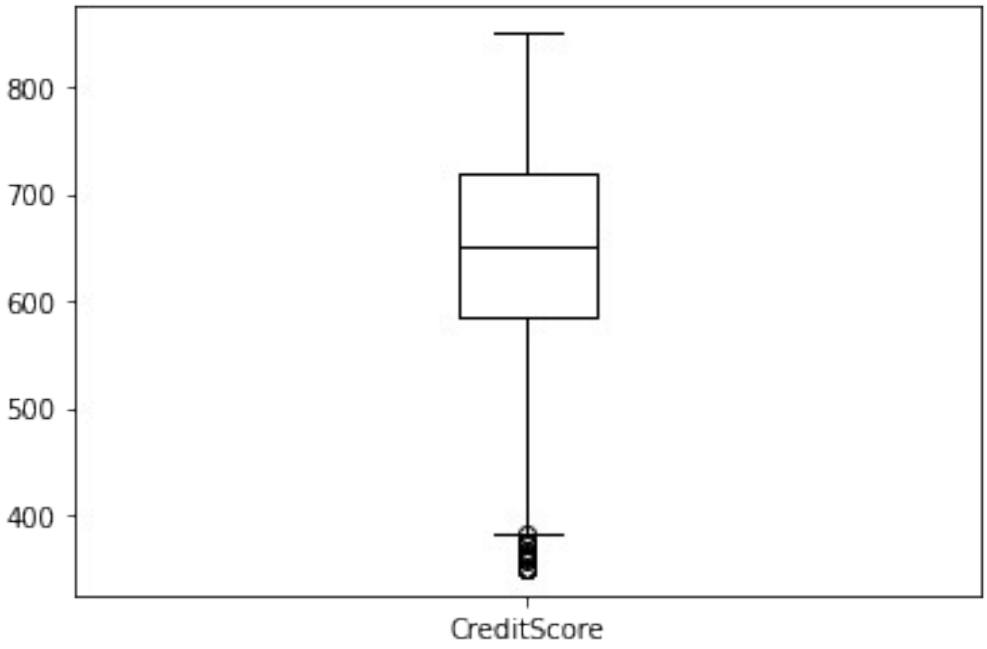
```
96.65329873613035
```

```
#2)Create frequency table

df['Age'].value_counts()
```

```
37    478
38    477
35    474
36    456
34    447
     ...
92      2
82      1
88      1
85      1
83      1
Name: Age, Length: 70, dtype: int64
```

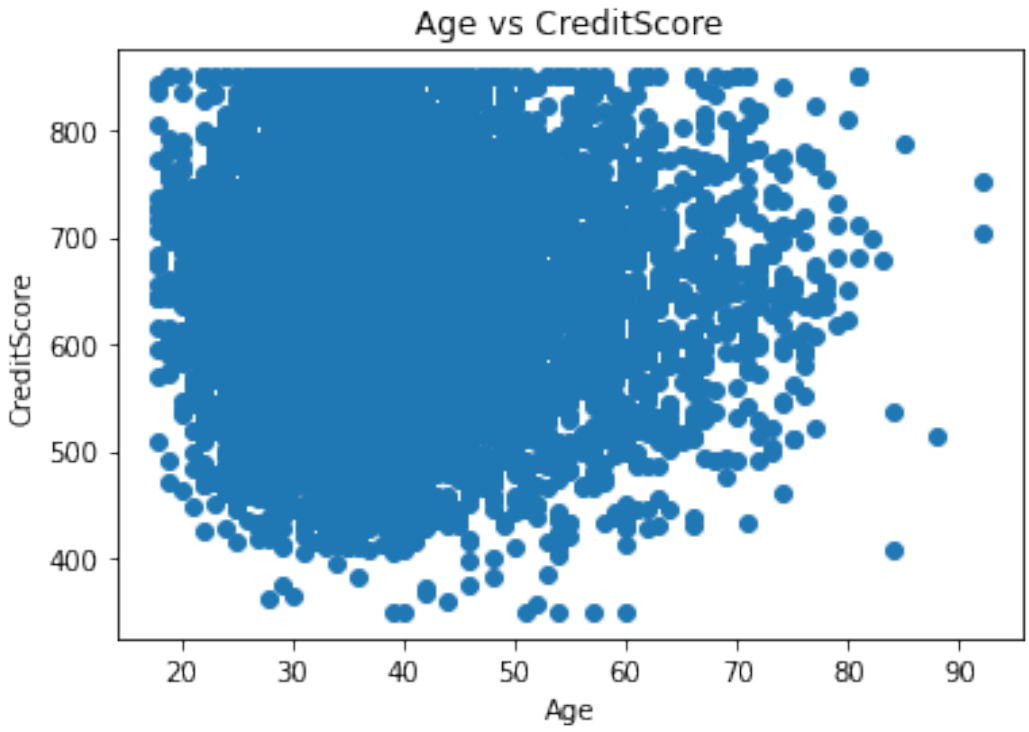
```
#3)create charts
import matplotlib.pyplot as plt
df.boxplot(column=['CreditScore'],grid=False, color='black')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8db5bd08d0>
```




```
#Bivariate analysis-
#1)Scatterplots
import matplotlib.pyplot as plt
plt.scatter(df.Age,df.CreditScore)
plt.title('Age vs CreditScore')
plt.xlabel('Age')
plt.ylabel('CreditScore')
```

```
Text(0, 0.5, 'CreditScore')
```




```
#2)Correlation Coefficients
df.corr()
```

```
                 RowNumber  CustomerId  CreditScore       Age
Tenure  \
RowNumber         1.000000    0.004202     0.005840  0.000783 -
0.006495
CustomerId        0.004202    1.000000     0.005308  0.009497 -
0.014883
CreditScore       0.005840    0.005308     1.000000 -0.003965
0.000842
Age               0.000783    0.009497    -0.003965  1.000000 -
0.009997
Tenure           -0.006495   -0.014883     0.000842 -0.009997
1.000000
Balance          -0.009067   -0.012419     0.006268  0.028308 -
0.012254
NumOfProducts     0.007246    0.016972     0.012238 -0.030680
0.013444
HasCrCard         0.000599   -0.014025    -0.005458 -0.011721
0.022583
IsActiveMember    0.012044    0.001665     0.025651  0.085472 -
0.028362
EstimatedSalary  -0.005988    0.015271    -0.001384 -0.007201
0.007784
Exited           -0.016571   -0.006248    -0.027094  0.285323 -
0.014001
```

```
                  Balance  NumOfProducts  HasCrCard  IsActiveMember  \
RowNumber       -0.009067       0.007246   0.000599        0.012044
CustomerId      -0.012419       0.016972  -0.014025        0.001665
CreditScore      0.006268       0.012238  -0.005458        0.025651
Age              0.028308      -0.030680  -0.011721        0.085472
Tenure          -0.012254       0.013444   0.022583       -0.028362
Balance          1.000000      -0.304180  -0.014858       -0.010084
NumOfProducts   -0.304180       1.000000   0.003183        0.009612
HasCrCard       -0.014858       0.003183   1.000000       -0.011866
IsActiveMember  -0.010084       0.009612  -0.011866        1.000000
EstimatedSalary  0.012797       0.014204  -0.009933       -0.011421
Exited           0.118533      -0.047820  -0.007138       -0.156128

                 EstimatedSalary    Exited
RowNumber              -0.005988 -0.016571
CustomerId              0.015271 -0.006248
CreditScore            -0.001384 -0.027094
Age                    -0.007201  0.285323
Tenure                  0.007784 -0.014001
Balance                 0.012797  0.118533
NumOfProducts           0.014204 -0.047820
HasCrCard              -0.009933 -0.007138
IsActiveMember         -0.011421 -0.156128
EstimatedSalary         1.000000  0.012097
Exited                  0.012097  1.000000
```

```
#3)Simple Linear Regressiion
import statsmodels.api as sm
y=df['CreditScore']
x=df[['Age']]
x=sm.add_constant(x)
model=sm.OLS(y,x).fit()
print(model.summary())
```

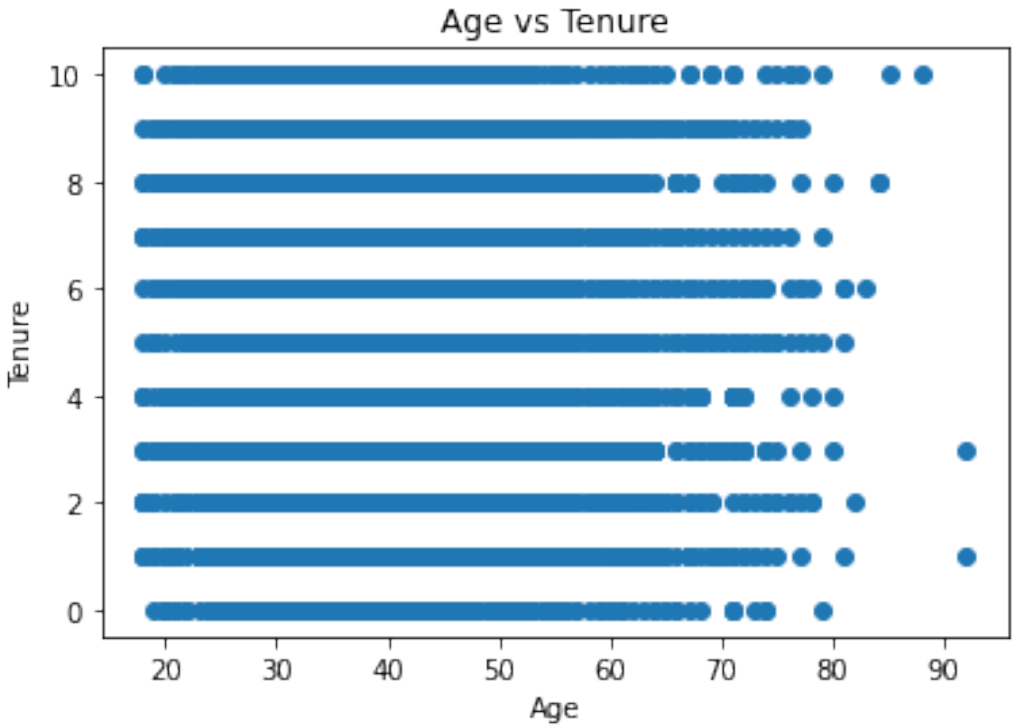
```
                            OLS Regression Results

==============================================================================
========
Dep. Variable:            CreditScore   R-squared:
0.000
Model:                            OLS   Adj. R-squared:
-0.000
Method:                 Least Squares   F-statistic:
0.1572
Date:                Mon, 26 Sep 2022   Prob (F-statistic):
0.692
Time:                        14:01:22   Log-Likelihood:
-59900.
No. Observations:               10000   AIC:
1.198e+05
```

```
Df Residuals:                     9998   BIC:
1.198e+05
Df Model:                            1

Covariance Type:            nonrobust

==============================================================================
========
                 coef    std err          t      P>|t|      [0.025
0.975]
------------------------------------------------------------------------------
--------
const        651.9510      3.715    175.481      0.000     644.668
659.234
Age           -0.0365      0.092     -0.396      0.692      -0.217
0.144
==============================================================================
========
Omnibus:                      133.033   Durbin-Watson:
2.014
Prob(Omnibus):                  0.000   Jarque-Bera (JB):
84.280
Skew:                          -0.071   Prob(JB):
5.00e-19
Kurtosis:                       2.574   Cond. No.
155.
==============================================================================
========

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is
correctly specified.
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tsa/
tsatools.py:142: FutureWarning: In a future version of pandas all
arguments of concat except for the argument 'objs' will be keyword-
only
  x = pd.concat(x[::order], 1)
```

```
#Multi-variate Analysis-scatterplots
import matplotlib.pyplot as plt
plt.scatter(df.Age,df.Tenure)
plt.title('Age vs Tenure')
plt.xlabel('Age')
plt.ylabel('Tenure')
```

```
Text(0, 0.5, 'Tenure')
```




```
#Descriptive Analysis
df.describe()
```

```
         RowNumber    CustomerId   CreditScore           Age
Tenure  \
count  10000.00000  1.000000e+04  10000.000000  10000.000000
10000.000000
mean    5000.50000  1.569094e+07    650.528800     38.921800
5.012800
std     2886.89568  7.193619e+04     96.653299     10.487806
2.892174
min        1.00000  1.556570e+07    350.000000     18.000000
0.000000
25%     2500.75000  1.562853e+07    584.000000     32.000000
3.000000
50%     5000.50000  1.569074e+07    652.000000     37.000000
5.000000
75%     7500.25000  1.575323e+07    718.000000     44.000000
7.000000
max    10000.00000  1.581569e+07    850.000000     92.000000
10.000000

             Balance  NumOfProducts    HasCrCard  IsActiveMember  \
count   10000.000000   10000.000000  10000.00000    10000.000000
mean    76485.889288       1.530200      0.70550        0.515100
std     62397.405202       0.581654      0.45584        0.499797
min         0.000000       1.000000      0.00000        0.000000
25%         0.000000       1.000000      0.00000        0.000000
```

```
50%     97198.540000       1.000000      1.00000        1.000000
75%    127644.240000       2.000000      1.00000        1.000000
max    250898.090000       4.000000      1.00000        1.000000

       EstimatedSalary        Exited
count     10000.000000  10000.000000
mean     100090.239881      0.203700
std       57510.492818      0.402769
min          11.580000      0.000000
25%       51002.110000      0.000000
50%      100193.915000      0.000000
75%      149388.247500      0.000000
max      199992.480000      1.000000
```

```
df.describe(include=['object'])
```

```
       Surname Geography Gender
count    10000     10000  10000
unique    2932         3      2
top      Smith    France   Male
freq        32      5014   5457
```

```
df.std()
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1:
FutureWarning: Dropping of nuisance columns in DataFrame reductions
(with 'numeric_only=None') is deprecated; in a future version this
will raise TypeError.  Select only valid columns before calling the
reduction.
  """Entry point for launching an IPython kernel.

RowNumber           2886.895680
CustomerId         71936.186123
CreditScore           96.653299
Age                   10.487806
Tenure                 2.892174
Balance            62397.405202
NumOfProducts          0.581654
HasCrCard              0.455840
IsActiveMember         0.499797
EstimatedSalary    57510.492818
Exited                 0.402769
dtype: float64
```

```
df.sum()
```

```
RowNumber                                                     50005000
CustomerId                                                  156909405694
Surname            HargraveHillOnioBoniMitchellChuBartlettObinnaH...
CreditScore                                                   6505288
Geography          FranceSpainFranceFranceSpainSpainFranceGermany...
Gender             FemaleFemaleFemaleFemaleFemaleMaleMaleFemaleMa...
```

```
Age                                                     389218
Tenure                                                   50128
Balance                                             764858892.88
NumOfProducts                                            15302
HasCrCard                                                 7055
IsActiveMember                                            5151
EstimatedSalary                                     1000902398.81
Exited                                                    2037
dtype: object
```

```
df.count()
```

```
RowNumber          10000
CustomerId         10000
Surname            10000
CreditScore        10000
Geography          10000
Gender             10000
Age                10000
Tenure             10000
Balance            10000
NumOfProducts      10000
HasCrCard          10000
IsActiveMember     10000
EstimatedSalary    10000
Exited             10000
dtype: int64
```

```
#Handle the Missing values.
df.isnull().sum()
```

```
RowNumber          0
CustomerId         0
Surname            0
CreditScore        0
Geography          0
Gender             0
Age                0
Tenure             0
Balance            0
NumOfProducts      0
HasCrCard          0
IsActiveMember     0
EstimatedSalary    0
Exited             0
dtype: int64
```

```
df.info()
```

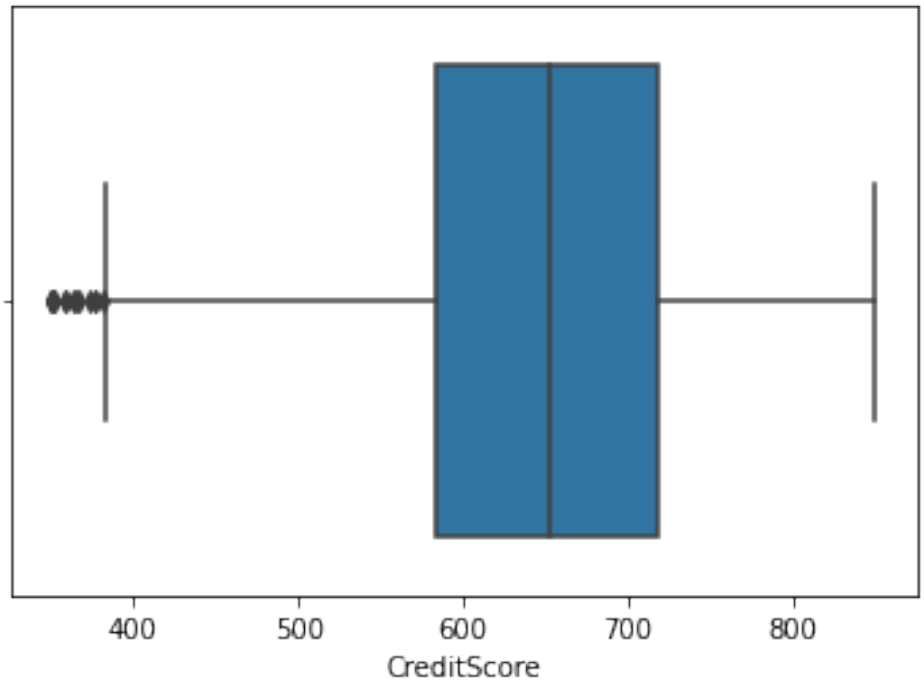
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
```

```
Data columns (total 14 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   RowNumber        10000 non-null  int64  
 1   CustomerId       10000 non-null  int64  
 2   Surname          10000 non-null  object 
 3   CreditScore      10000 non-null  int64  
 4   Geography        10000 non-null  object 
 5   Gender           10000 non-null  object 
 6   Age              10000 non-null  int64  
 7   Tenure           10000 non-null  int64  
 8   Balance          10000 non-null  float64
 9   NumOfProducts    10000 non-null  int64  
 10  HasCrCard        10000 non-null  int64  
 11  IsActiveMember   10000 non-null  int64  
 12  EstimatedSalary  10000 non-null  float64
 13  Exited           10000 non-null  int64  
dtypes: float64(2), int64(9), object(3)
memory usage: 1.1+ MB
```

```
#there are no missing values in the given dataset
import seaborn as sns
sns.boxplot(df['CreditScore'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43: 
FutureWarning: Pass the following variable as a keyword arg: x. From 
version 0.12, the only valid positional argument will be `data`, and 
passing other arguments without an explicit keyword will result in an 
error or misinterpretation.
  FutureWarning
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8d976d3fd0>
```




```
np.where(df['CreditScore']<400)
```

```
(array([   7,  942, 1193, 1201, 1405, 1631, 1838, 1962, 2473, 2579,
5285,
        5494, 6253, 8154, 8723, 8762, 9210, 9356, 9624]),)
```

```
df['CreditScore'].mean()
```

```
650.5288
```

```
df['CreditScore']=np.where(df['CreditScore']<400,650.5288,df['CreditSc
ore'])
df.head(10)
```

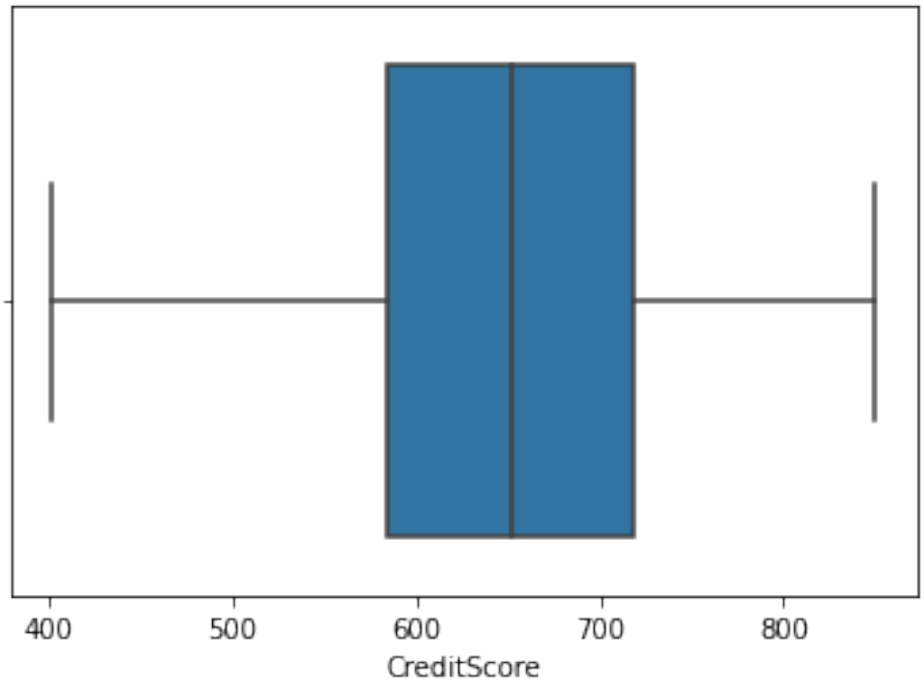
```
   RowNumber  CustomerId   Surname  CreditScore Geography  Gender  Age
\
0          1    15634602  Hargrave     619.0000    France  Female   42

1          2    15647311      Hill     608.0000     Spain  Female   41

2          3    15619304      Onio     502.0000    France  Female   42

3          4    15701354      Boni     699.0000    France  Female   39

4          5    15737888  Mitchell     850.0000     Spain  Female   43

5          6    15574012       Chu     645.0000     Spain    Male   44

6          7    15592531  Bartlett     822.0000    France    Male   50
```

```
7          8    15656148    Obinna     650.5288   Germany  Female   29

8          9    15792365        He     501.0000    France    Male   44

9         10    15592389        H?     684.0000    France    Male   27
```

```
   Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0       2       0.00              1          1               1
1       1   83807.86              1          0               1
2       8  159660.80              3          1               0
3       1       0.00              2          0               0
4       2  125510.82              1          1               1
5       8  113755.78              2          1               0
6       7       0.00              2          1               1
7       4  115046.74              4          1               0
8       4  142051.07              2          0               1
9       2  134603.88              1          1               1

   EstimatedSalary  Exited
0        101348.88       1
1        112542.58       0
2        113931.57       1
3         93826.63       0
4         79084.10       0
5        149756.71       1
6         10062.80       0
7        119346.88       1
8         74940.50       0
9         71725.73       0
```

```
#boxplot after identifying and replacing the outliers with the mean
value of the column

sns.boxplot(df['CreditScore'])
```

```
/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:
FutureWarning: Pass the following variable as a keyword arg: x. From
version 0.12, the only valid positional argument will be `data`, and
passing other arguments without an explicit keyword will result in an
error or misinterpretation.
  FutureWarning

<matplotlib.axes._subplots.AxesSubplot at 0x7f8d9a7a0b50>
```




```
#Check for Categorical columns and perform encoding.
df_categorical=df[['Geography','Gender']]
df['Gender'].unique()
#two unique values

array(['Female', 'Male'], dtype=object)

df['Geography'].unique()
#three unique values

array(['France', 'Spain', 'Germany'], dtype=object)

#encoding categorical values with two distinct values
from sklearn.preprocessing import LabelEncoder
en_gen = LabelEncoder()

en_gen.fit(df_categorical['Gender'])
LabelEncoder()
values_gen=en_gen.transform(df_categorical['Gender'])
"After encoding",values_gen

('After encoding', array([0, 0, 0, ..., 0, 1, 0]))

#encoding categorical values with more than two distinct values
from sklearn.preprocessing import OneHotEncoder
import numpy as np
geo_encoder = OneHotEncoder()
geo_reshaped = np.array(df_categorical['Geography']).reshape(-1, 1)
geo_values = geo_encoder.fit_transform(geo_reshaped)
print(geo_values.toarray())
```

```
print()
print(geo_encoder.inverse_transform(geo_values))
```

```
[[1. 0. 0.]
 [0. 0. 1.]
 [1. 0. 0.]
 ...
 [1. 0. 0.]
 [0. 1. 0.]
 [1. 0. 0.]]

[['France']
 ['Spain']
 ['France']
 ...
 ['France']
 ['Germany']
 ['France']]
```

```
#independent variable
X = df.iloc[:, :-1].values
print(X)
```

```
[[1 15634602 'Hargrave' ... 1 1 101348.88]
 [2 15647311 'Hill' ... 0 1 112542.58]
 [3 15619304 'Onio' ... 1 0 113931.57]
 ...
 [9998 15584532 'Liu' ... 0 1 42085.58]
 [9999 15682355 'Sabbatini' ... 1 0 92888.52]
 [10000 15628319 'Walker' ... 1 0 38190.78]]
```

```
#dependent variable
Y = df.iloc[:,-1].values
print(Y)
```

```
[1 0 1 ... 1 1 0]
```

```
#Scale the independent variables
X = df[["CreditScore", "Age", "Tenure", "EstimatedSalary"]].values
y=df[["Exited"]]
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()
scaler.fit(X)
X
```

```
array([[6.1900000e+02, 4.2000000e+01, 2.0000000e+00, 1.0134888e+05],
       [6.0800000e+02, 4.1000000e+01, 1.0000000e+00, 1.1254258e+05],
       [5.0200000e+02, 4.2000000e+01, 8.0000000e+00, 1.1393157e+05],
       ...,
       [7.0900000e+02, 3.6000000e+01, 7.0000000e+00, 4.2085580e+04],
```

```
       [7.7200000e+02, 4.2000000e+01, 3.0000000e+00, 9.2888520e+04],
       [7.9200000e+02, 2.8000000e+01, 4.0000000e+00, 3.8190780e+04]])
```

```
#Split the data into training and testing
from sklearn.model_selection import train_test_split
xtrain,xtest,ytrain,ytest =
train_test_split(X,Y,test_size=0.3,random_state=10)
```

```
xtrain.shape,xtest.shape
```

```
((7000, 13), (3000, 13))
```

```
ytrain.shape,ytest.shape
```

```
((7000,), (3000,))
```