Assignment 2

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

import warnings
warnings.filterwarnings("ignore")
```

1.Load The Data Set

```
import os
os.path.exists("Churn_Modelling.csv")
```

```
True
```

```
df = pd.read_csv("Churn_Modelling.csv")
```

```
pwd
```

```
'/content'
```

Perform below visualizations

2.Univariate Analysis

```
df.head()
```

	CustomerId	RowNumber	Surname	CreditScore	Geography
0	15634602	1	Hargrave	619	France
1	15647311	2	Hill	608	Spain
2	15619304	3	Onio	502	France
3	15701354	4	Boni	699	France
4	15737888	5	Mitchell	850	Spain

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

```
650.5288
```

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

```
652.0
```

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

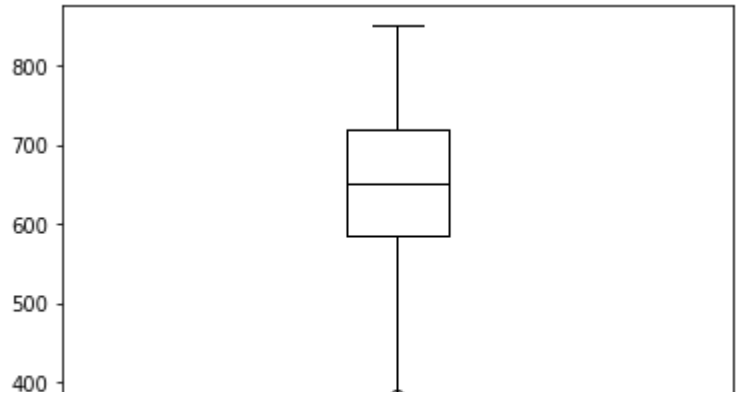
```
96.65329873613035
```

```
#CREATE FREQUENT TABLE
df['CreditScore'].value_counts()
```

```
850    233
678     63
655     54
705     53
667     53
       ...
404      1
351      1
365      1
417      1
419      1
Name: CreditScore, Length: 460, dtype: int64
```

```
df.boxplot(column=['CreditScore'],grid=False,color='black')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff058fd51d0>
```

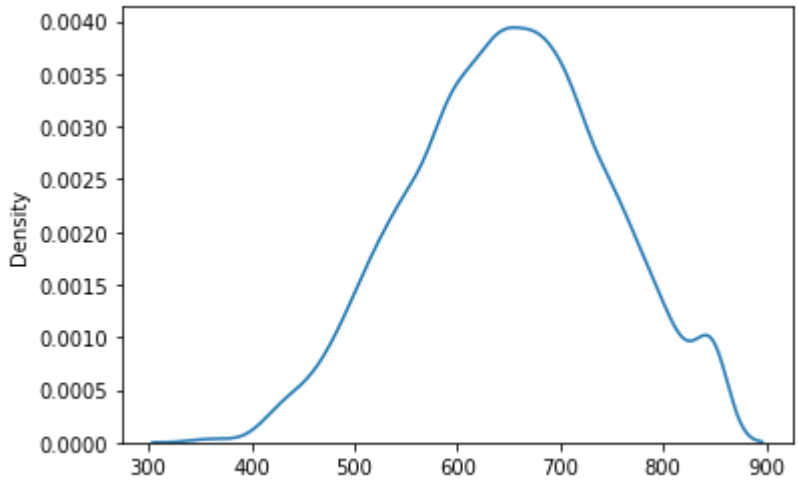



```
df.hist(column='CreditScore',grid=False,edgecolor='black')
```

```
array([[<matplotlib.axes._subplots.AxesSubplot object at
0x7ff0573839d0>]],
      dtype=object)
```


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

```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff057375350>
```




```
df.shape
```

```
(10000, 14)
```

```
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
```

```
df.nunique()
```

```
RowNumber          10000
CustomerId         10000
Surname             2932
CreditScore          460
Geography              3
Gender                 2
Age                   70
Tenure                11
Balance             6382
NumOfProducts          4
HasCrCard              2
IsActiveMember         2
EstimatedSalary     9999
Exited                 2
dtype: int64
```

```
df["CreditScore"].unique()
```

```
array([619, 608, 502, 699, 850, 645, 822, 376, 501, 684, 528, 497, 476,
       549, 635, 616, 653, 587, 726, 732, 636, 510, 669, 846, 577, 756,
       571, 574, 411, 591, 533, 553, 520, 722, 475, 490, 804, 582, 472,
       465, 556, 834, 660, 776, 829, 637, 550, 698, 585, 788, 655, 601,
       656, 725, 511, 614, 742, 687, 555, 603, 751, 581, 735, 661, 675,
       738, 813, 657, 604, 519, 664, 678, 757, 416, 665, 777, 543, 506,
       493, 652, 750, 729, 646, 647, 808, 524, 769, 730, 515, 773, 814,
       710, 413, 623, 670, 622, 785, 605, 479, 685, 538, 562, 721, 628,
       668, 828, 674, 625, 432, 770, 758, 795, 686, 789, 589, 461, 584,
       579, 663, 682, 793, 691, 485, 650, 754, 535, 716, 539, 706, 586,
       631, 717, 800, 683, 704, 615, 667, 484, 480, 578, 512, 606, 597,
       778, 514, 525, 715, 580, 807, 521, 759, 516, 711, 618, 643, 671,
       689, 620, 676, 572, 695, 592, 567, 694, 547, 594, 673, 610, 767,
       763, 712, 703, 662, 659, 523, 772, 545, 634, 739, 771, 681, 544,
       696, 766, 727, 693, 557, 531, 498, 651, 791, 733, 811, 707, 714,
       782, 775, 799, 602, 744, 588, 747, 583, 627, 731, 629, 438, 642,
       806, 474, 559, 429, 680, 749, 734, 644, 626, 649, 805, 718, 840,
       630, 654, 762, 568, 613, 522, 737, 648, 443, 640, 540, 460, 593,
       801, 611, 802, 745, 483, 690, 492, 709, 705, 560, 752, 701, 537,
       487, 596, 702, 486, 724, 548, 464, 790, 534, 748, 494, 590, 468,
       509, 818, 816, 536, 753, 774, 621, 569, 658, 798, 641, 542, 692,
       639, 765, 570, 638, 599, 632, 779, 527, 564, 833, 504, 842, 508,
       417, 598, 741, 607, 761, 848, 546, 439, 755, 760, 526, 713, 700,
       666, 566, 495, 688, 612, 477, 427, 839, 819, 720, 459, 503, 624,
       529, 563, 482, 796, 445, 746, 786, 554, 672, 787, 499, 844, 450,
       815, 838, 803, 736, 633, 600, 679, 517, 792, 743, 488, 421, 841,
       708, 507, 505, 456, 435, 561, 518, 565, 728, 784, 552, 609, 764,
       697, 723, 551, 444, 719, 496, 541, 830, 812, 677, 420, 595, 617,
       809, 500, 826, 434, 513, 478, 797, 363, 399, 463, 780, 452, 575,
       837, 794, 824, 428, 823, 781, 849, 489, 431, 457, 768, 831, 359,
       820, 573, 576, 558, 817, 449, 440, 415, 821, 530, 350, 446, 425,
       740, 481, 783, 358, 845, 451, 458, 469, 423, 404, 836, 473, 835,
       466, 491, 351, 827, 843, 365, 532, 414, 453, 471, 401, 810, 832,
       470, 447, 422, 825, 430, 436, 426, 408, 847, 418, 437, 410, 454,
```

```
            407, 455, 462, 386, 405, 383, 395, 467, 433, 442, 424, 448, 441,
            367, 412, 382, 373, 419])
```

```
df.duplicated()
```

```
0       False
1       False
2       False
3       False
4       False
        ...
9995    False
9996    False
9997    False
9998    False
9999    False
Length: 10000, dtype: bool
```

```
df.duplicated().sum()
```

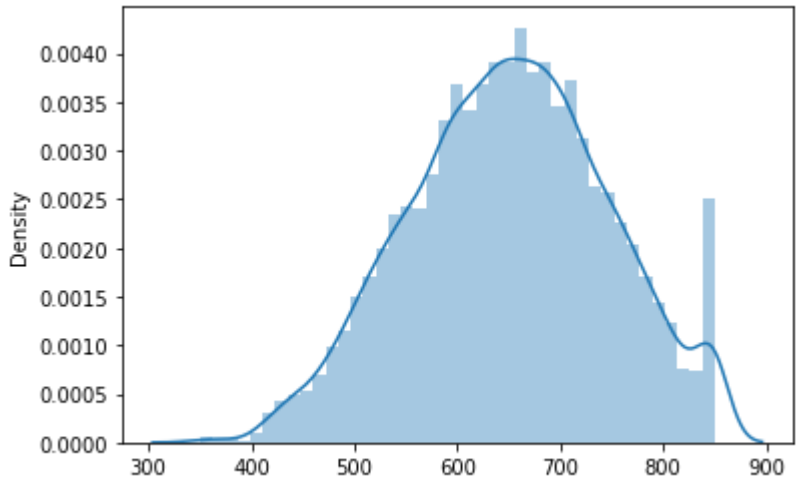
```
0
```

```
df.columns
```

```
Index(['RowNumber', 'CustomerId', 'Surname', 'CreditScore', 'Geography',
       'Gender', 'Age', 'Tenure', 'Balance', 'NumOfProducts', 'HasCrCard',
       'IsActiveMember', 'EstimatedSalary', 'Exited'],
      dtype='object')
```

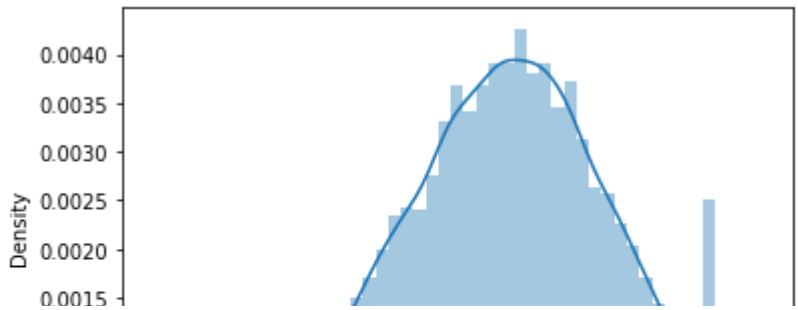
```
sns.distplot(df["CreditScore"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff023c82490>
```




```
sns.distplot(df["CreditScore"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff023ec3510>
```



3.Handling Missing values

```
df.isna()
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Genc
0	False	False	False	False	False	Fa
1	False	False	False	False	False	Fa
2	False	False	False	False	False	Fa
3	False	False	False	False	False	Fa
4	False	False	False	False	False	Fa
...	...	...	...	...	...	
9995	False	False	False	False	False	Fa
9996	False	False	False	False	False	Fa
9997	False	False	False	False	False	Fa
9998	False	False	False	False	False	Fa
9999	False	False	False	False	False	Fa

10000 rows × 14 columns

```
df.isnull()
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Genc
0	False	False	False	False	False	Fa
1	False	False	False	False	False	Fa
2	False	False	False	False	False	Fa
3	False	False	False	False	False	Fa
4	False	False	False	False	False	Fa
...	...	...	...	...	...	
9995	False	False	False	False	False	Fa
9996	False	False	False	False	False	Fa
9997	False	False	False	False	False	Fa

```
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
```

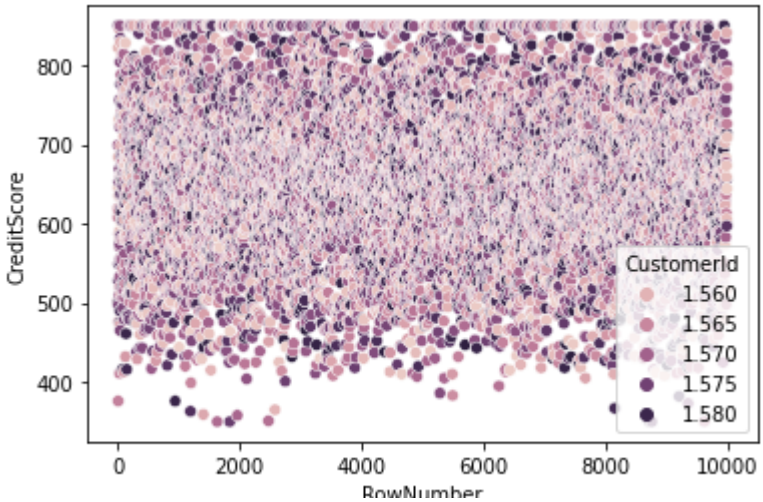
```
df.describe()
```

	RowNumber	CustomerId	CreditScore	Age	Tenu
count	10000.00000	1.000000e+04	10000.000000	10000.000000	10000.0000

4.Multi-Variate Analysis

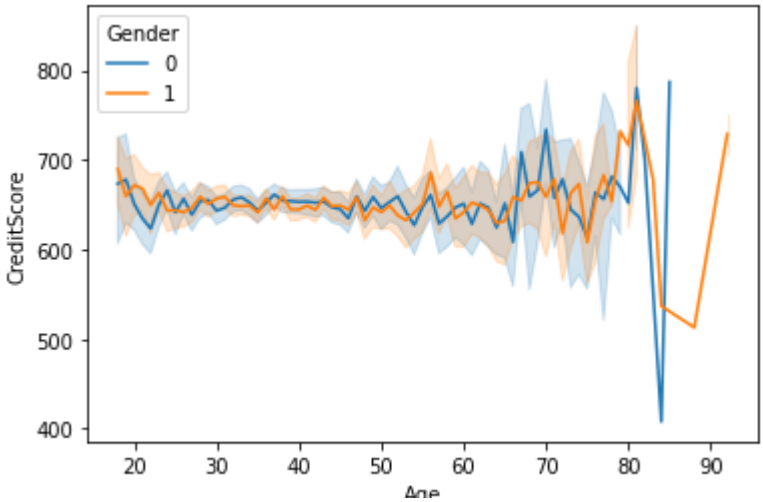
```
sns.scatterplot(df["RowNumber"],df["CreditScore"],hue=df["CustomerId"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f88948174d0>
```



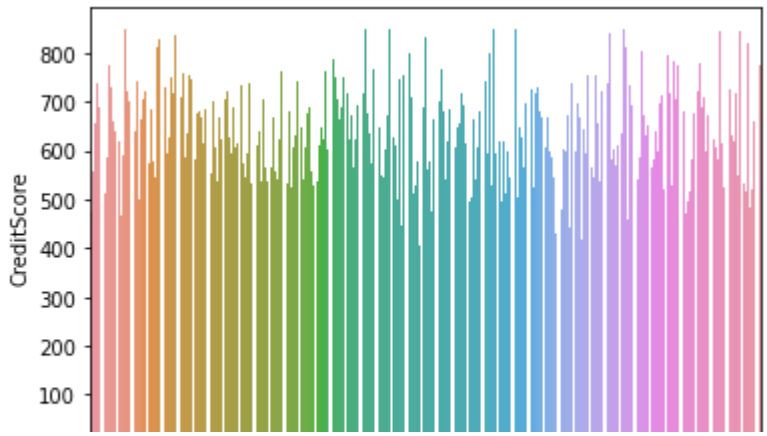

```
sns.lineplot(model["Age"],df["CreditScore"],hue=model["Gender"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8888cca810>
```




```
sns.barplot(df["RowNumber"],df["CreditScore"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff0393a0310>
```




```
df.skew()
```

```
RowNumber          0.000000
CustomerId         0.001149
CreditScore       -0.071607
Age                1.011320
Tenure             0.010991
Balance           -0.141109
NumOfProducts      0.745568
HasCrCard         -0.901812
IsActiveMember    -0.060437
EstimatedSalary    0.002085
Exited             1.471611
dtype: float64
```

```
plt.pie(model["Age"],labels = model["Tenure"],autopct = "%0.0f%%")
```

```
([<matplotlib.patches.Wedge at 0x7f8887f54190>,
  <matplotlib.patches.Wedge at 0x7f888802b0d0>,
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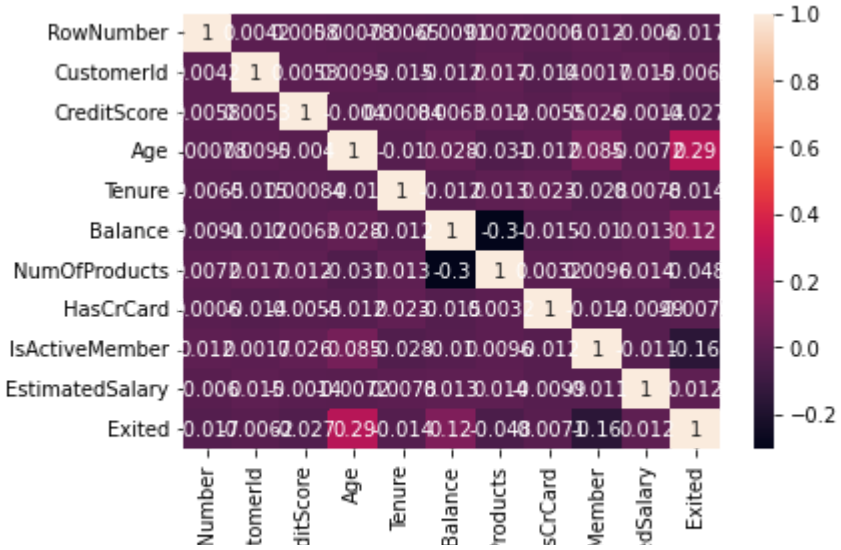
Text(0.4975523761179276, 0.33532317697917086, '0%'),
Text(0.49737367138222527, 0.3355881866451294, '0%'),
Text(0.49716500413443193, 0.33589724420425104, '0%'),
Text(0.4969615721883014, 0.33619814956083804, '0%'),
Text(0.4967851171825647, 0.3364588345487534, '0%'),
Text(0.4966193965689873, 0.3367033931392063, '0%'),
Text(0.49644539634176443, 0.336959891457527, '0%'),
Text(0.4962358767459265, 0.3372683718201302, '0%'),
Text(0.4959498593121231, 0.3376888168836588, '0%'),
Text(0.4956361933878953, 0.33814902602840186, '0%'),
Text(0.4953740234725604, 0.3385329775200744, '0%'),
Text(0.49515258625179653, 0.33885677848931567, '0%'),
Text(0.4948816533488482, 0.3392523385014618, '0%'),
Text(0.49459395496451236, 0.33967163513099224, '0%'),
Text(0.4943717734612125, 0.33999492585157143, '0%'),
Text(0.4941356457654367, 0.34033801372161593, '0%'),
Text(0.4938965301363698, 0.34068492411501555, '0%'),
Text(0.49359385140437906, 0.34112330594052315, '0%'),
Text(0.493334890327719, 0.3414977100733437, '0%'),
Text(0.49315841388658677, 0.3417525110556848, '0%'),
Text(0.49297076347686536, 0.34202313716623967, '0%'),
Text(0.49278849017306403, 0.3422857051542642, '0%'),
Text(0.49260331210542013, 0.3425521520918676, '0%'),
Text(0.49234049924971074, 0.3429297782324328, '0%'),
Text(0.49204691374028636, 0.3433508914778861, '0%'),
Text(0.4918112311673158, 0.3436883950582112, '0%'),
Text(0.4916003071827562, 0.34399002598595746, '0%'),
Text(0.4914114289132115, 0.3442597965686317, '0%'),
Text(0.491214059798495, 0.34454135812160575, '0%'),
Text(0.49091631145798137, 0.344965469495847, '0%'),
Text(0.49058752890647944, 0.3454328827448744, '0%'),
Text(0.49038390669729, 0.34572188830373984, '0%'),
Text(0.49019407805958126, 0.3459909909742118, '0%'),
Text(0.48996776593795854, 0.34631140371314056, '0%'),
Text(0.4897664237782475, 0.34659609077349113, '0%'),
Text(0.4895705158699696, 0.3468727576371656, '0%'),
Text(0.4893492320886198, 0.34718486293944045, '0%'),
Text(0.48912213959943496, 0.3475047230667101, '0%'),
Text(0.4888808002181305, 0.3478441650769499, '0%'),
Text(0.48861674120977583, 0.3482149913624324, '0%'),
Text(0.4884114800599294, 0.34850283520463526, '0%'),
Text(0.4882116798370614, 0.34878267685003317, '0%'),
Text(0.48799763150481446, 0.34908209871846946, '0%'),
Text(0.4878087786898242, 0.34934595379529165, '0%'),
Text(0.48763953568471863, 0.34958215520416946, '0%'),
Text(0.4874814723621732, 0.34980253587360927, '0%'),
Text(0.4872922300226724, 0.35006611169824897, '0%'),
Text(0.4870943619180438, 0.350341380067576, '0%'),
Text(0.4869104880139151, 0.3505968862697599, '0%'),
Text(0.48668399768090287, 0.35091122296292393, '0%'),
Text(0.48644029424593543, 0.3512489717193884, '0%'),
Text(0.4862360831984185, 0.35153160796130495, '0%'),
Text(0.4860175091086799, 0.3518337403373846, '0%'),
Text(0.48581864248233475, 0.3521082881964317, '0%'),
Text(0.4856167764801281, 0.35238664333519976, '0%'),

```
Text(0.4854119044200554, 0.3526688007852339, '0%'),
Text(0.48520401953897874, 0.35295475549030114, '0%'),
Text(0.4849018594292472, 0.35336975920706426, '0%'),
Text(0.48464502975004964, 0.3537219178091365, '0%'),
Text(0.4844565254343781, 0.35398004882203427, '0%'),
...])
```

```
sns.heatmap(df.corr(),annot = True)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fefe1e60d90>
```

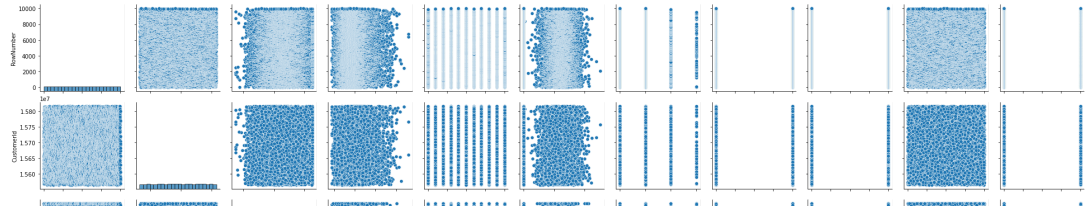



```
df.corr().CreditScore.sort_values()
```

```
Exited            -0.027094
HasCrCard         -0.005458
Age               -0.003965
EstimatedSalary   -0.001384
Tenure             0.000842
CustomerId         0.005308
RowNumber          0.005840
Balance            0.006268
NumOfProducts      0.012238
IsActiveMember     0.025651
CreditScore        1.000000
Name: CreditScore, dtype: float64
```

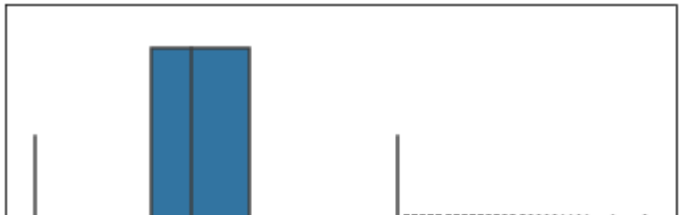
```
sns.pairplot(df)
```

```
<seaborn.axisgrid.PairGrid at 0x7ff00335f710>
```



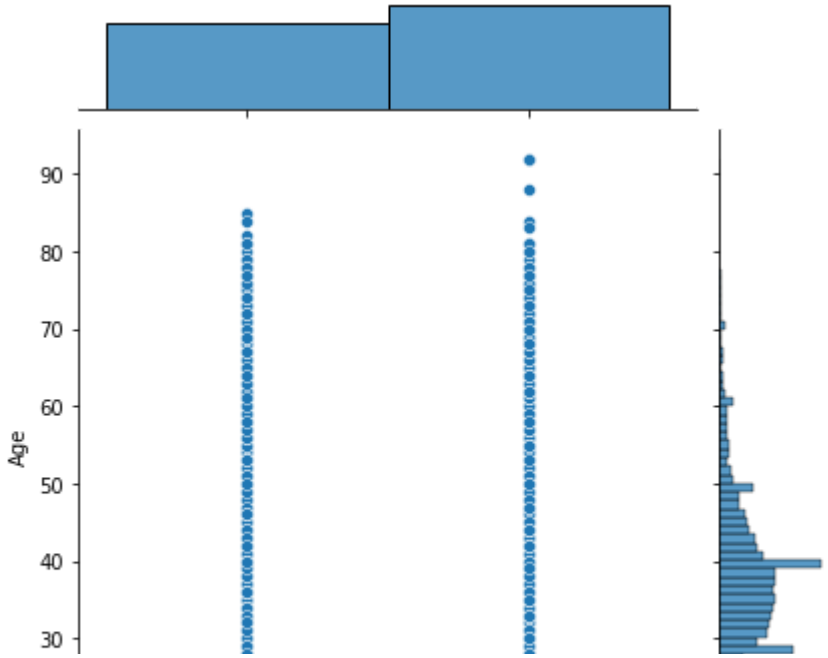

```
sns.boxplot(df["Age"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fefe44e00d0>
```



```
sns.jointplot(df["Gender"],df["Age"])
```

```
<seaborn.axisgrid.JointGrid at 0x7fefe2064410>
```



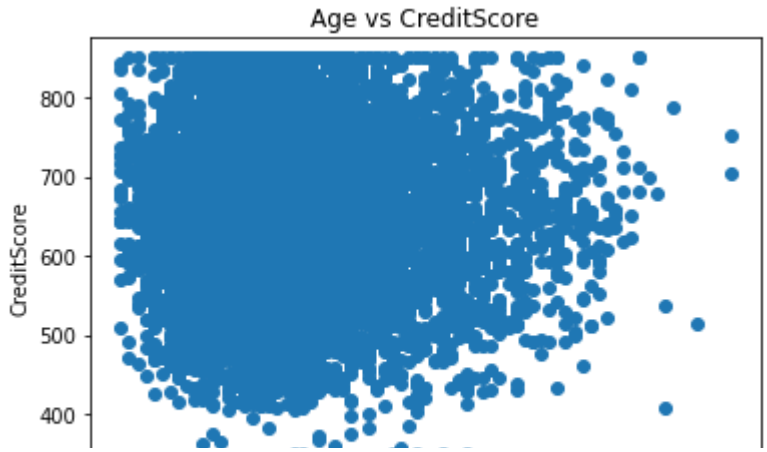

```
df.corr()
```

	RowNumber	CustomerId	CreditScore	Age	Tenu
RowNumber	1.000000	0.004202	0.005840	0.000783	-0.0064
CustomerId	0.004202	1.000000	0.005308	0.009497	-0.0148
CreditScore	0.005840	0.005308	1.000000	-0.003965	0.0008

5.Bi-variate Analysis

```
plt.scatter(df.Age,df.CreditScore)
plt.title('Age vs CreditScore')
plt.xlabel('Age')
plt.ylabel('CreditScore')
```

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




```
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())
```

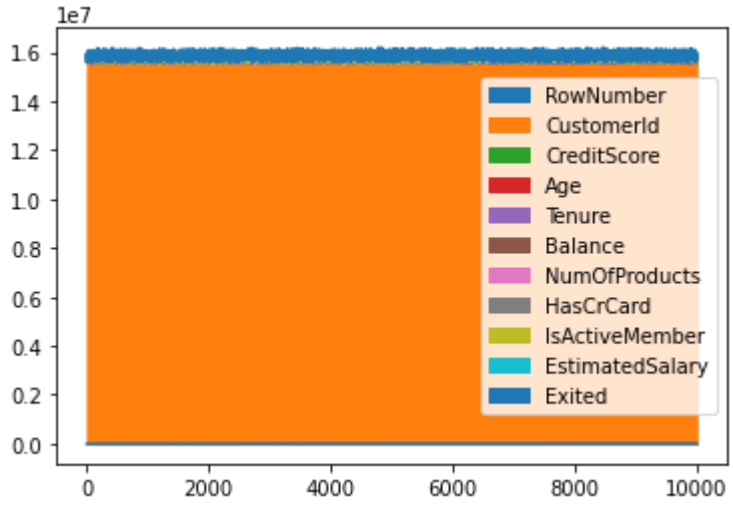
```
                            OLS Regression Results
==============================================================================
Dep. Variable:            CreditScore   R-squared:                       0.000
Model:                            OLS   Adj. R-squared:                 -0.000
Method:                 Least Squares   F-statistic:                    0.1572
Date:                Wed, 21 Sep 2022   Prob (F-statistic):              0.692
Time:                        15:22:35   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 correctl
```

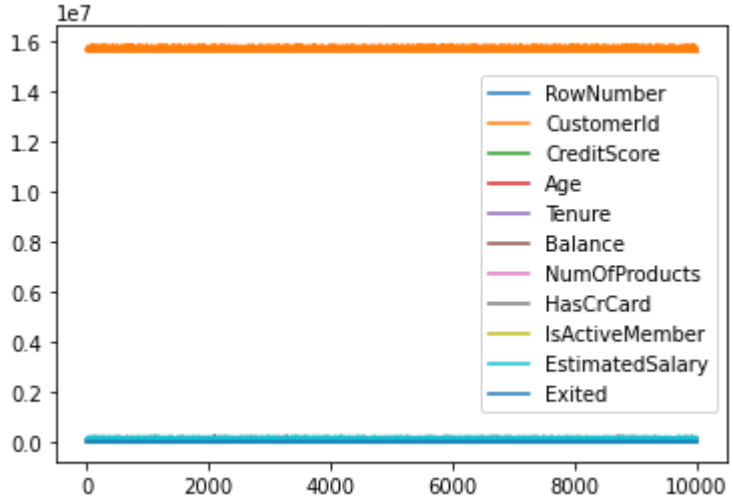
```
df.plot.area()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff057c01890>
```




```
df.plot.line()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fefd958fcd0>
```



Descriptive Statisctics

```
df['Gender'].describe()
```

```
count     10000
unique        2
top        Male
freq       5457
Name: Gender, dtype: object
```

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

```
Male      5457
Female    4543
Name: Gender, dtype: int64
```

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

```
1.3953470615086956
```

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

```
1.0113202630234552
```

```
df.mean(axis=1)
```

```
0       1.430602e+06
1       1.440392e+06
2       1.444860e+06
3       1.435993e+06
4       1.449399e+06
              ...
9995    1.428483e+06
9996    1.430866e+06
9997    1.421579e+06
9998    1.441922e+06
9999    1.437044e+06
Length: 10000, dtype: float64
```

```
df.median()
```

```
RowNumber          5.000500e+03
CustomerId         1.569074e+07
CreditScore        6.520000e+02
Age                3.700000e+01
Tenure             5.000000e+00
Balance            9.719854e+04
NumOfProducts      1.000000e+00
HasCrCard          1.000000e+00
IsActiveMember     1.000000e+00
EstimatedSalary    1.001939e+05
Exited             0.000000e+00
dtype: float64
```

```
df.mean()
```

```
RowNumber          5.000500e+03
CustomerId         1.569094e+07
CreditScore        6.505288e+02
Age                3.892180e+01
Tenure             5.012800e+00
Balance            7.648589e+04
NumOfProducts      1.530200e+00
HasCrCard          7.055000e-01
IsActiveMember     5.151000e-01
EstimatedSalary    1.000902e+05
Exited             2.037000e-01
dtype: float64
```

```
max(df["Age"]) - min(df["Tenure"])
```

```
92
```

```
five_num = [df["Age"].quantile(0),
            df["Age"].quantile(0.25),
              df["Age"].quantile(0.50),
            df["Age"].quantile(0.75),
            df["Age"].quantile(1)]

five_num
```

```
[18.0, 32.0, 37.0, 44.0, 92.0]
```

```
df["Age"].describe()
```

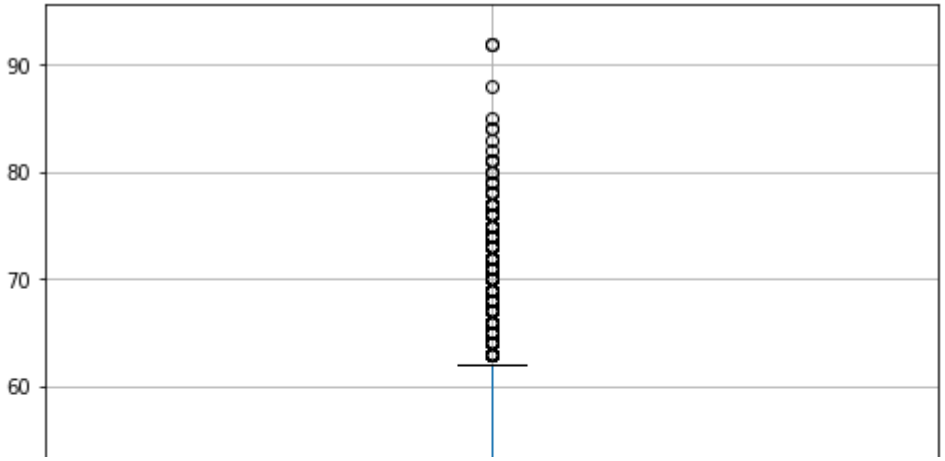
```
count    10000.000000
mean        38.921800
std         10.487806
min         18.000000
25%         32.000000
50%         37.000000
75%         44.000000
max         92.000000
Name: Age, dtype: float64
```

```
df["Age"].quantile(0.75) - df["Age"].quantile(0.25)
```

```
12.0
```

```
df.boxplot(column="Age",
               return_type='axes',
               figsize=(8,8))
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fd124226e10>
```




```
df["Age"].var()
```

```
109.99408416841683
```

```
df["Age"].std()
```

```
10.487806451704609
```

```
abs_median_devs = abs(df["Age"] - df["Age"].median())
abs_median_devs.median() * 1.4826
```

```
8.8956
```

```
df["Age"].skew()
```

```
1.0113202630234552
```

```
df["Age"].kurt()
```

```
1.3953470615086956
```

```
updated_df = df.dropna(axis=1)
```

```
updated_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
```

```
y = df['Age']
df.drop("Age",axis=1,inplace=True)
```

```
df.isnull()
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Genc
0	False	False	False	False	False	Fa
1	False	False	False	False	False	Fa
2	False	False	False	False	False	Fa
3	False	False	False	False	False	Fa
4	False	False	False	False	False	Fa
...	...	...	...	...	...	
9995	False	False	False	False	False	Fa
9996	False	False	False	False	False	Fa
9997	False	False	False	False	False	Fa
9998	False	False	False	False	False	Fa
9999	False	False	False	False	False	Fa

10000 rows × 13 columns

```
data=pd.read_csv("Churn_Modelling.csv")
bool_series=pd.isnull(data["Age"])
data[bool_series]
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender
0	1	15634602	Hargrave	619	France	Female
1	2	15647311	Hill	608	Spain	Female
2	3	15619304	Onio	502	France	Female
3	4	15701354	Boni	699	France	Female
4	5	15737888	Mitchell	850	Spain	Female

```
df.notnull()
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Genc
0	True	True	True	True	True	T
1	True	True	True	True	True	T
2	True	True	True	True	True	T
3	True	True	True	True	True	T
4	True	True	True	True	True	T
...	...	...	...	...	...	
9995	True	True	True	True	True	T
9996	True	True	True	True	True	T
9997	True	True	True	True	True	T
9998	True	True	True	True	True	T
9999	True	True	True	True	True	T

10000 rows × 13 columns

```
bool_series=pd.notnull(data["Gender"])
data[bool_series]
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 14 columns

```
df.fillna(0)
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer

```
df.fillna(method='pad')
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 13 columns

```
df.fillna(method='bfill')
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer

```
data=pd.read_csv("Churn_Modelling.csv")
data[10:25]
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gend
10	11	15767821	Bearce	528	France	Ma
11	12	15737173	Andrews	497	Spain	Ma
12	13	15632264	Kay	476	France	Fema
13	14	15691483	Chin	549	France	Fema
14	15	15600882	Scott	635	Spain	Fema
15	16	15643966	Goforth	616	Germany	Ma
16	17	15737452	Romeo	653	Germany	Ma
17	18	15788218	Henderson	549	Spain	Fema
18	19	15661507	Muldrow	587	Spain	Ma
19	20	15568982	Hao	726	France	Fema
20	21	15577657	McDonald	732	France	Ma
21	22	15597945	Dellucci	636	Spain	Fema
22	23	15699309	Gerasimov	510	Spain	Fema
23	24	15725737	Mosman	669	France	Ma
24	25	15625047	Yen	846	France	Fema

```
data["Gender"].fillna("No Gender",inplace=True)
data
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 14 columns

```
data.replace(to_replace=np.nan,value=1)
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 14 columns

```
df.interpolate(method='linear',limit_direction='forward')
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 13 columns

```
df.dropna()
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer

```
df.dropna(how='all')
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 13 columns

```
df.dropna(axis=1)
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer

```
new_data=data.dropna(axis=0,how='any')
new_data
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 14 columns

```
print("Old data framelength:",len(data))
print("New data frame length:",len(new_data))
print("Number of rows with at least 1 NA value:",(len(data)-len(new_data)))
```

```
Old data framelength: 10000
New data frame length: 10000
Number of rows with at least 1 NA value: 0
```

```
df.dropna(axis=1)
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Ger
0	1	15634602	Hargrave	619	France	Fer
1	2	15647311	Hill	608	Spain	Fer
2	3	15619304	Onio	502	France	Fer
3	4	15701354	Boni	699	France	Fer
4	5	15737888	Mitchell	850	Spain	Fer
...	...	...	...	...	...	
9995	9996	15606229	Obijiaku	771	France	M
9996	9997	15569892	Johnstone	516	France	M
9997	9998	15584532	Liu	709	France	Fer
9998	9999	15682355	Sabbatini	772	Germany	M
9999	10000	15628319	Walker	792	France	Fer

10000 rows × 13 columns

6.Split the data into training and testing

```
from sklearn.datasets import make_blobs
from sklearn.model_selection import train_test_split
g, k = make_blobs(n_samples=1000)
g_train, g_test, k_train, k_test = train_test_split(g, k, test_size=0.33)
print(g_train.shape, g_test.shape, k_train.shape, k_test.shape)
```

```
(670, 2) (330, 2) (670,) (330,)
```

```
df=df.iloc[:,[1,0,2,3,4]]
```

```
df.head()
```

	CustomerId	RowNumber	Surname	CreditScore	Geography
0	15634602	1	Hargrave	619	France
1	15647311	2	Hill	608	Spain
2	15619304	3	Onio	502	France
3	15701354	4	Boni	699	France
4	15737888	5	Mitchell	850	Spain

```
df.shape
```

```
(10000, 5)
```

```
df.nunique()
```

```
CustomerId     10000
RowNumber      10000
Surname         2932
CreditScore      460
Geography          3
dtype: int64
```

```
df.columns
```

```
Index(['CustomerId', 'RowNumber', 'Surname', 'CreditScore', 'Geography'],
dtype='object')
```

**Find layer and replace the outlayers **

```
qnt=df.quantile(q=(0.25,0.75))
iqr=qnt.loc[0.75]-qnt.loc[0.25]
```

```
iqr
```

```
CustomerId     124705.5
RowNumber        4999.5
CreditScore       134.0
dtype: float64
```

```
lower=qnt.loc[0.75]-1.5*iqr
```

```
lower
```

```
CustomerId     15566175.5
RowNumber             1.0
CreditScore         517.0
dtype: float64
```

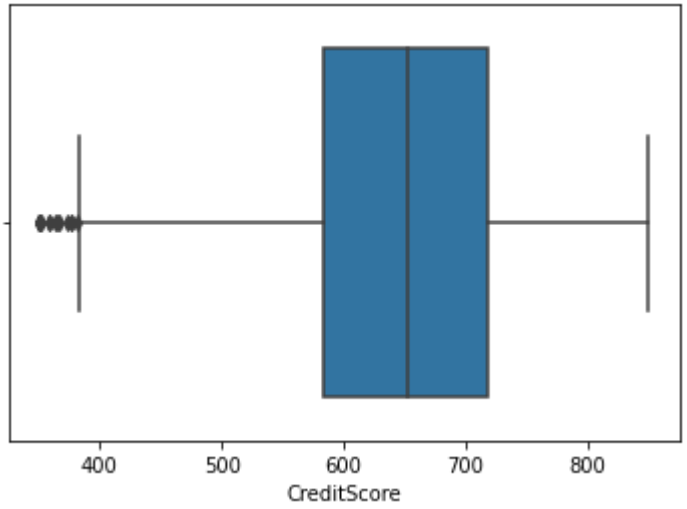
```
upper=qnt.loc[0.75]+1.5*iqr
```

```
upper
```

```
CustomerId     15940292.0
RowNumber         14999.5
CreditScore         919.0
dtype: float64
```

```
sns.boxplot(x=df["CreditScore"])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8892a658d0>
```




```
df.dtypes
```

```
CustomerId      int64
RowNumber       int64
Surname        object
CreditScore     int64
Geography      object
dtype: object
```

7.Categorical Value of Encoding

```
model=pd.read_csv("Churn_Modelling.csv")
```

```
model["Gender"].replace({"Female":0,"Male":1},inplace=True)
```

```
model.head()
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender
0	1	15634602	Hargrave	619	France	0
1	2	15647311	Hill	608	Spain	0
2	3	15619304	Onio	502	France	0
3	4	15701354	Boni	699	France	0
4	5	15737888	Mitchell	850	Spain	0

8.Split the data into dependent and independent variables

```
x=df.iloc[:,:-1].values
y=df.iloc[:,3].values
```

```
x
```

```
array([[15634602, 1, 'Hargrave', 619],
       [15647311, 2, 'Hill', 608],
       [15619304, 3, 'Onio', 502],
       ...,
       [15584532, 9998, 'Liu', 709],
       [15682355, 9999, 'Sabbatini', 772],
       [15628319, 10000, 'Walker', 792]], dtype=object)
```

```
y
```

```
array([619, 608, 502, ..., 709, 772, 792])
```

9.Scale The independent variables

```
from sklearn.preprocessing import StandardScaler
credit_score=model[["CreditScore","EstimatedSalary"]]
```

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

```
StandardScaler()
```

Perform descriptive statistics on the dataset

```
model.sum()
```

```
RowNumber                                                    50005000
CustomerId                                                156909405694
Surname            HargraveHillOnioBoniMitchellChuBartlettObinnaH...
CreditScore                                                  6505288
Geography          FranceSpainFranceFranceSpainSpainFranceGermany...
Gender                                                          5457
Age                                                           389218
Tenure                                                         50128
Balance                                                764858892.88
NumOfProducts                                                 15302
HasCrCard                                                      7055
IsActiveMember                                                 5151
EstimatedSalary                                      1000902398.81
Exited                                                        2037
dtype: object
```

10.Perform descriptive statistics on the dataset

```
model.mean(numeric_only=True)
```

```
RowNumber          5.000500e+03
CustomerId         1.569094e+07
CreditScore        6.505288e+02
Gender             5.457000e-01
Age                3.892180e+01
Tenure             5.012800e+00
Balance            7.648589e+04
NumOfProducts      1.530200e+00
HasCrCard          7.055000e-01
IsActiveMember     5.151000e-01
EstimatedSalary    1.000902e+05
Exited             2.037000e-01
dtype: float64
```

```
model.median(numeric_only=True)
```

```
RowNumber          5.000500e+03
CustomerId         1.569074e+07
CreditScore        6.520000e+02
Gender             1.000000e+00
Age                3.700000e+01
Tenure             5.000000e+00
Balance            9.719854e+04
NumOfProducts      1.000000e+00
HasCrCard          1.000000e+00
IsActiveMember     1.000000e+00
EstimatedSalary    1.001939e+05
Exited             0.000000e+00
dtype: float64
```

```
model.mode(numeric_only=True)
```

	RowNumber	CustomerId	CreditScore	Gender	Age	Tenure	Bal
0	1	15565701	850.0	1.0	37.0	2.0	
1	2	15565706	NaN	NaN	NaN	NaN	

```
model.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
```

```
model.std(numeric_only=True)
```

```
RowNumber           2886.895680
CustomerId         71936.186123
CreditScore           96.653299
Gender                 0.497932
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
```

```
model.min()
```

```
RowNumber              1
CustomerId         15565701
Surname              Abazu
CreditScore            350
Geography           France
Gender                   0
Age                     18
Tenure                   0
Balance                0.0
NumOfProducts            1
HasCrCard                0
IsActiveMember           0
EstimatedSalary      11.58
```

```
Exited                    0
dtype: object
```

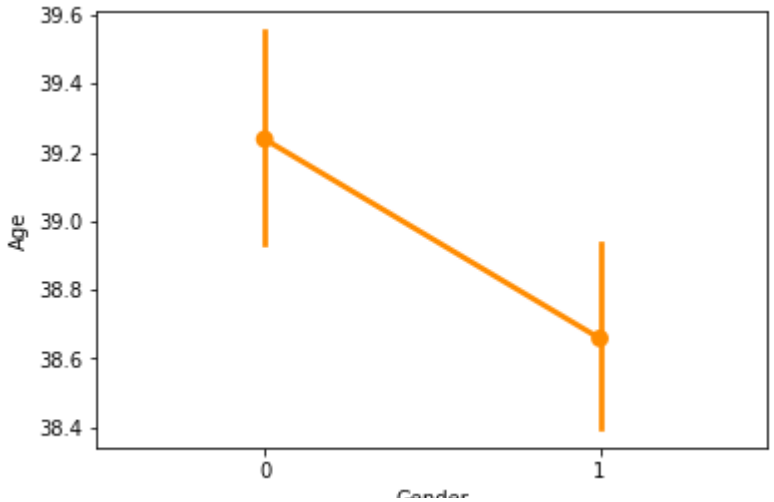
```
model.max()
```

```
RowNumber              10000
CustomerId          15815690
Surname                Zuyeva
CreditScore               850
Geography               Spain
Gender                      1
Age                        92
Tenure                     10
Balance             250898.09
NumOfProducts               4
HasCrCard                   1
IsActiveMember              1
EstimatedSalary     199992.48
Exited                      1
dtype: object
```

11. Bi - Variate Analysis

```
sns.pointplot(x='Gender',y='Age',data=model,color='darkorange')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f888888a650>
```




```
sns.pointplot(x=model['CreditScore'],y=model['Balance'],color='darkorange')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8888821810>
```