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

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

Loading the dataset provided in assignment folder

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

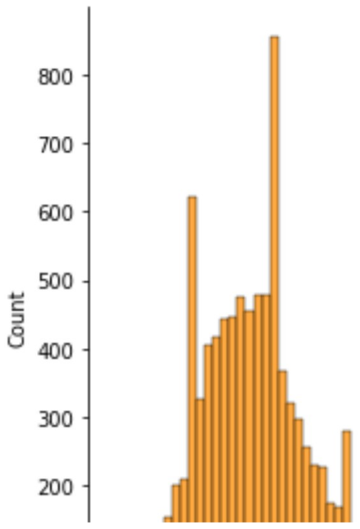
	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActive
count	10000.00000	1.000000e+04	10000.000000	10000.000000	10000.000000	10000.000000	10000.000000	10000.00000	10000.0
mean	5000.50000	1.569094e+07	650.528800	38.921800	5.012800	76485.889288	1.530200	0.70550	0.5
std	2886.89568	7.193619e+04	96.653299	10.487806	2.892174	62397.405202	0.581654	0.45584	0.4
min	1.00000	1.556570e+07	350.000000	18.000000	0.000000	0.000000	1.000000	0.00000	0.0
25%	2500.75000	1.562853e+07	584.000000	32.000000	3.000000	0.000000	1.000000	0.00000	0.0
50%	5000.50000	1.569074e+07	652.000000	37.000000	5.000000	97198.540000	1.000000	1.00000	1.0
75%	7500.25000	1.575323e+07	718.000000	44.000000	7.000000	127644.240000	2.000000	1.00000	1.0
max	10000.00000	1.581569e+07	850.000000	92.000000	10.000000	250898.090000	4.000000	1.00000	1.0

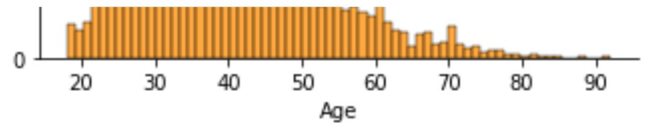
1. UNIVARIATE ANALYSIS

Histogram

```
sns.displot(df["Age"], color='darkorange')
```

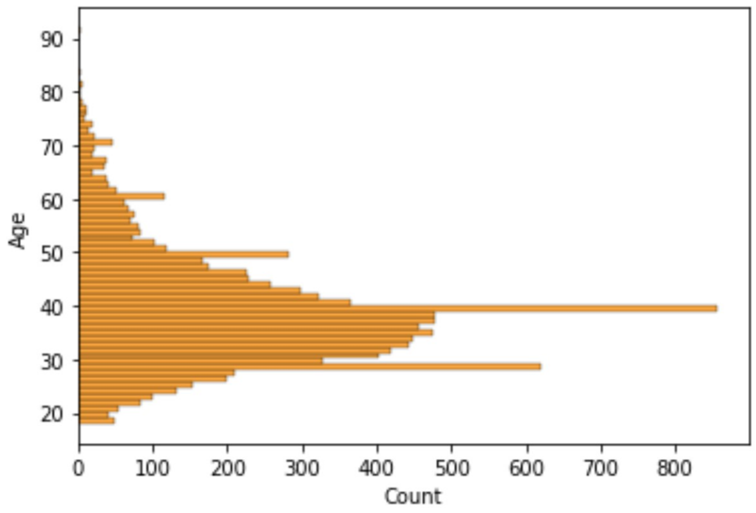
```
<seaborn.axisgrid.FacetGrid at 0x7f8c9a668e50>
```





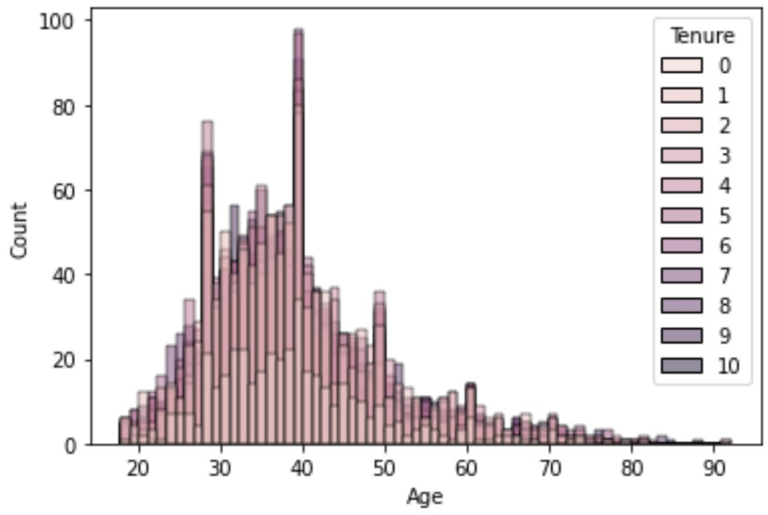
```
sns.histplot(y="Age",data=df,color='darkorange')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c97b6fd10>
```



```
sns.histplot(x='Age',data=df,hue=df['Tenure'])
```

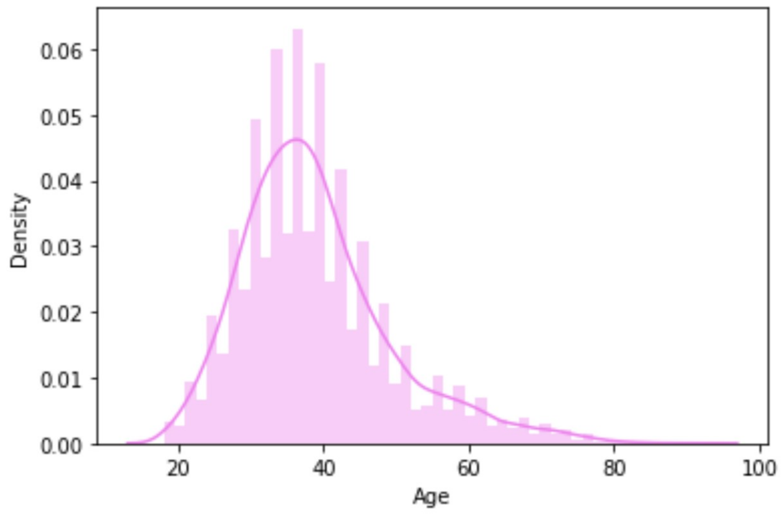
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c975fbfd0>
```



Distplot

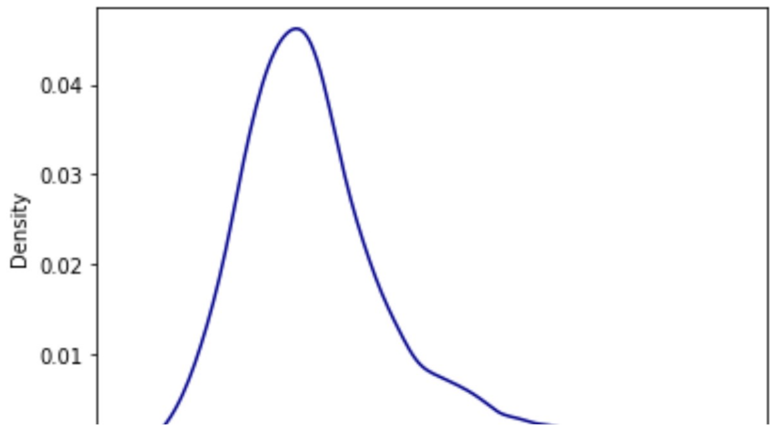
```
sns.distplot(df["Age"],color='violet')
```

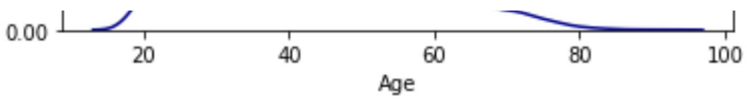
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c975b4450>
```



```
sns.distplot(df["Age"],hist=False,color='darkblue')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c97624990>
```

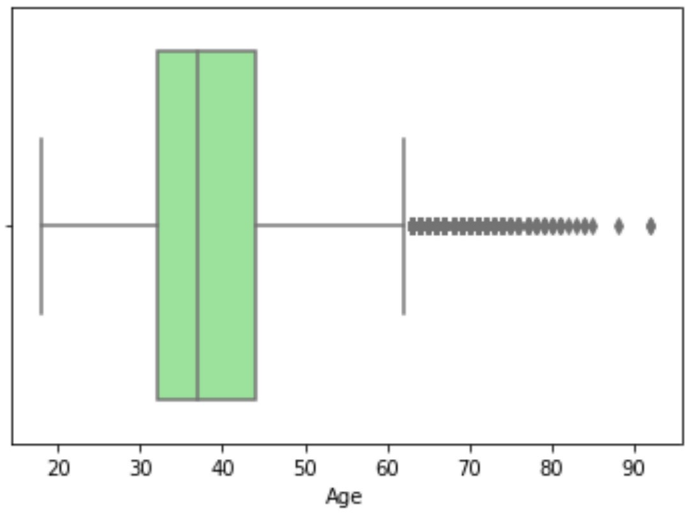




Boxplot

```
sns.boxplot(df["Age"],color='lightgreen')
```

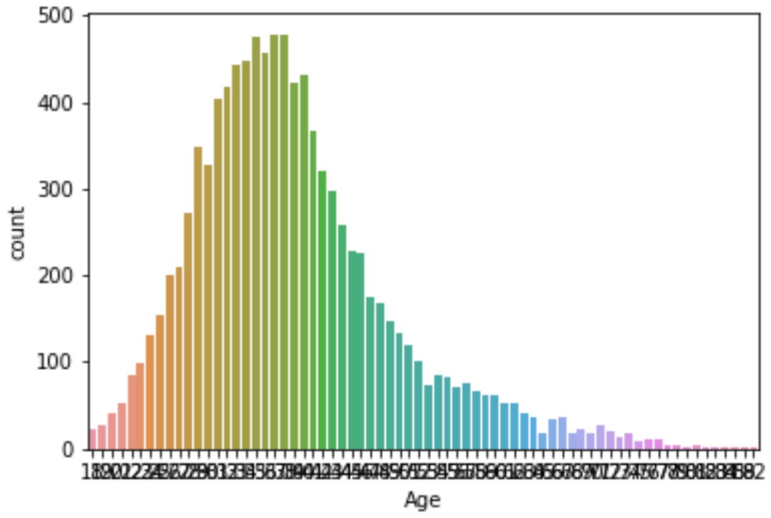
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c96b41dd0>
```



Countplot

```
sns.countplot(df['Age'])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c96ad4b10>
```

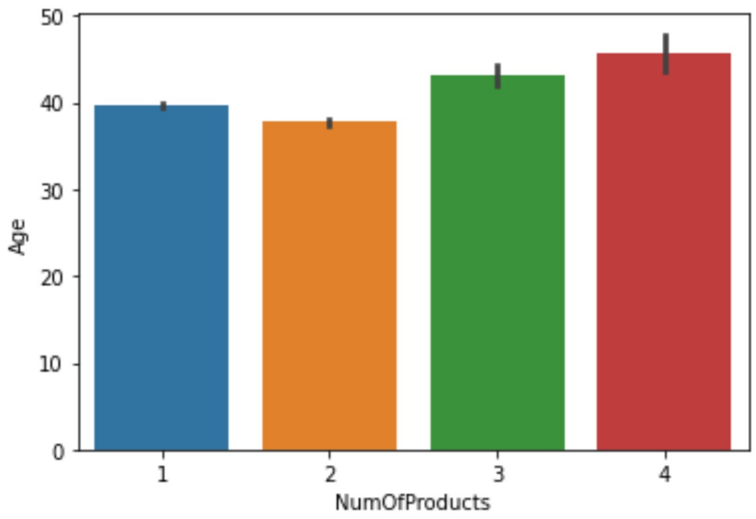


2. BIVARIATE ANALYSIS

Barplot

```
sns.barplot(df["NumOfProducts"],df["Age"])
```

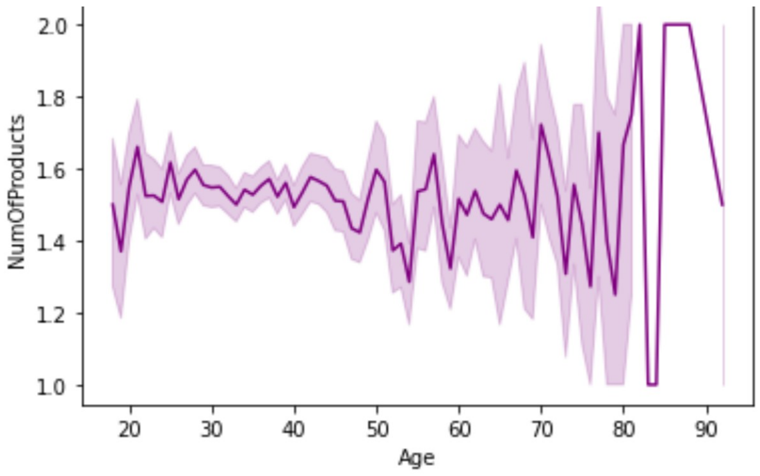
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c968bb490>
```



Linearplot

```
sns.lineplot(df["Age"],df["NumOfProducts"], color='purple')
```

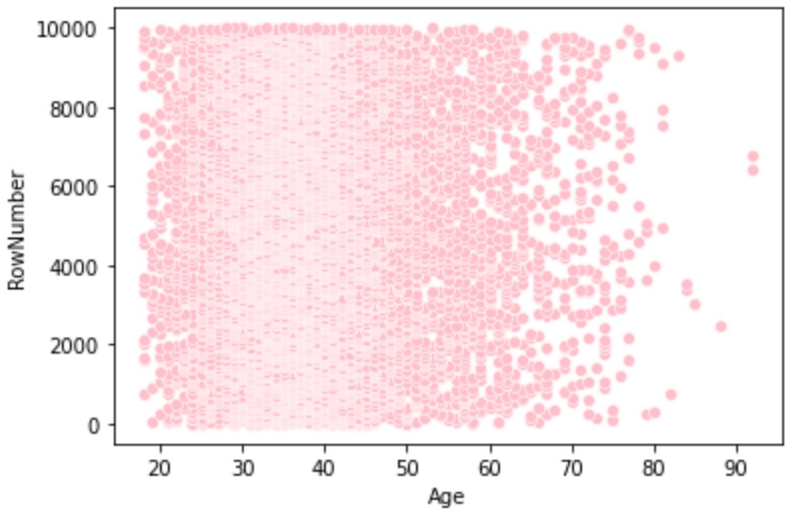
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c96861b50>
```



Scatterplot

```
sns.scatterplot(x=df.Age,y=df.RowNumber,color='pink')
```

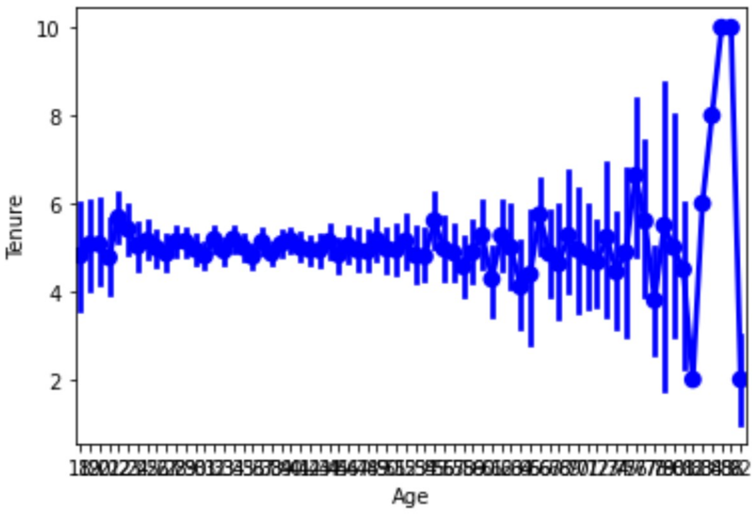
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c967cc450>
```



Pointplot

```
sns.pointplot(x='Age',y='Tenure',data=df,color='blue')
```

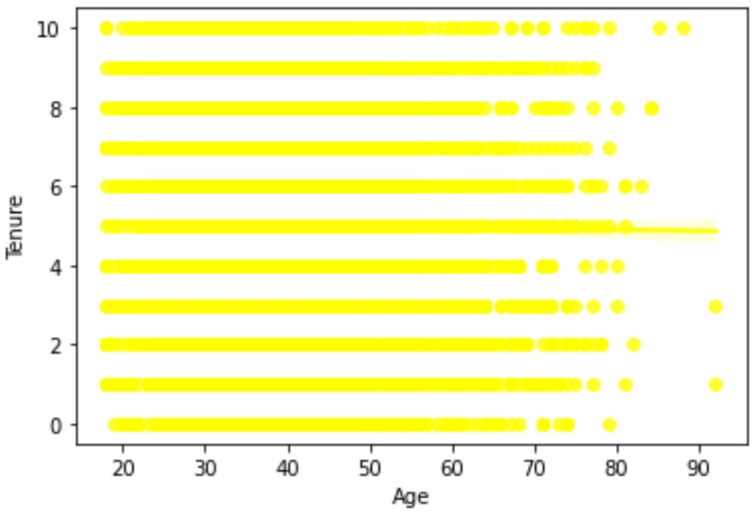
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c96e66550>
```



Regplot

```
sns.regplot(df['Age'],df['Tenure'],color='yellow')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8c94d54810>
```



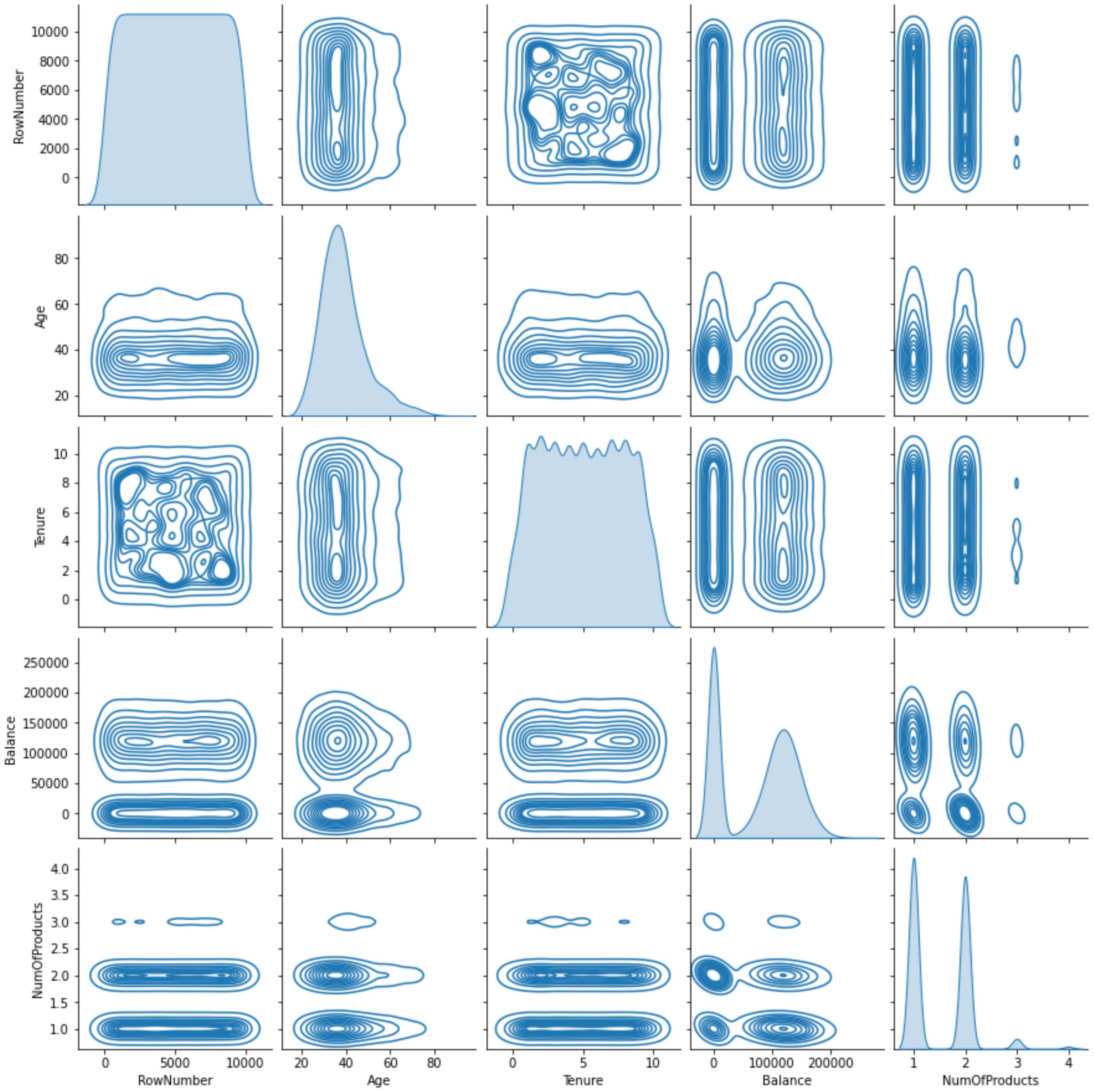
3. MULTI - VARIATE ANALYSIS

3. MULTI - VARIATE ANALYSIS

Pairplot

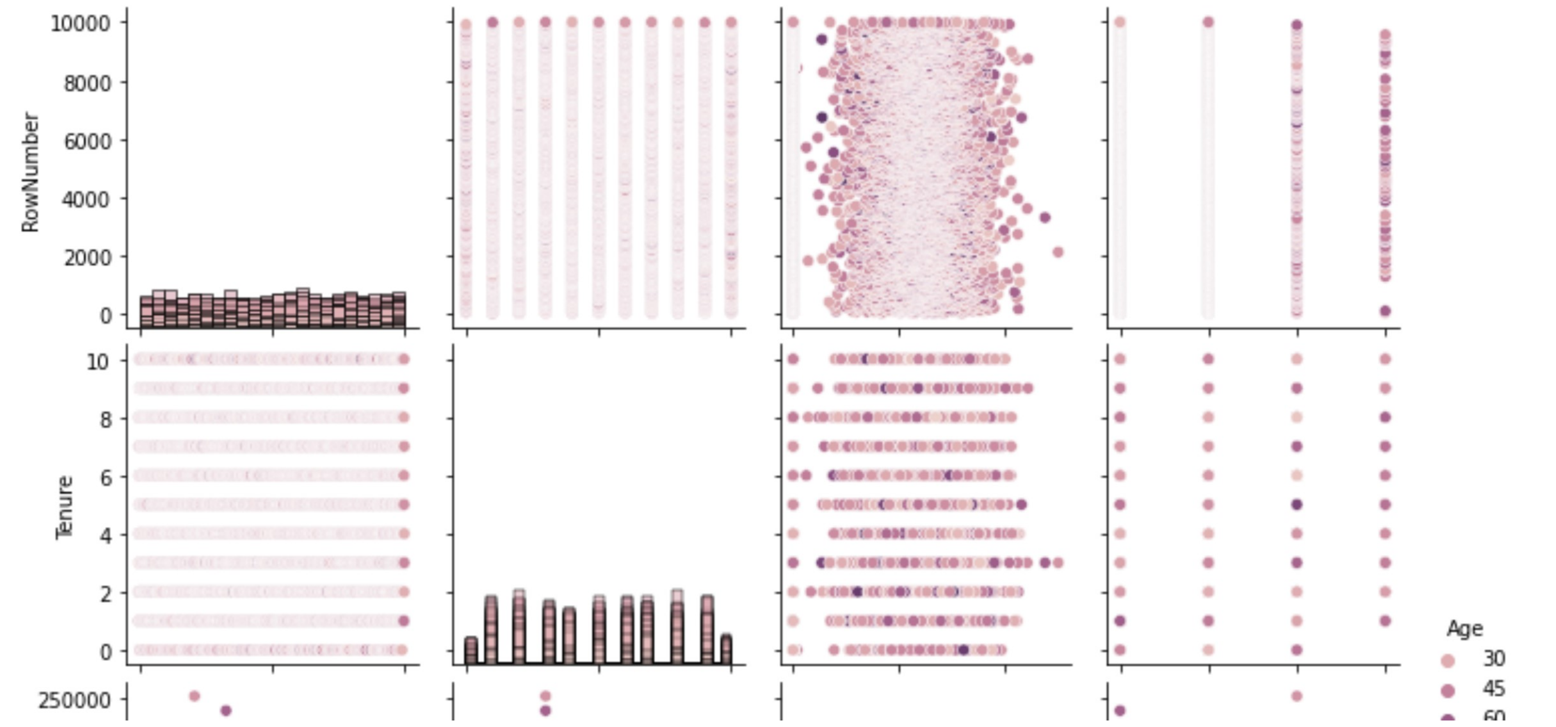
```
sns.pairplot(data=df[["RowNumber","Age","Tenure","Balance","NumOfProducts"]],kind="kde")
```

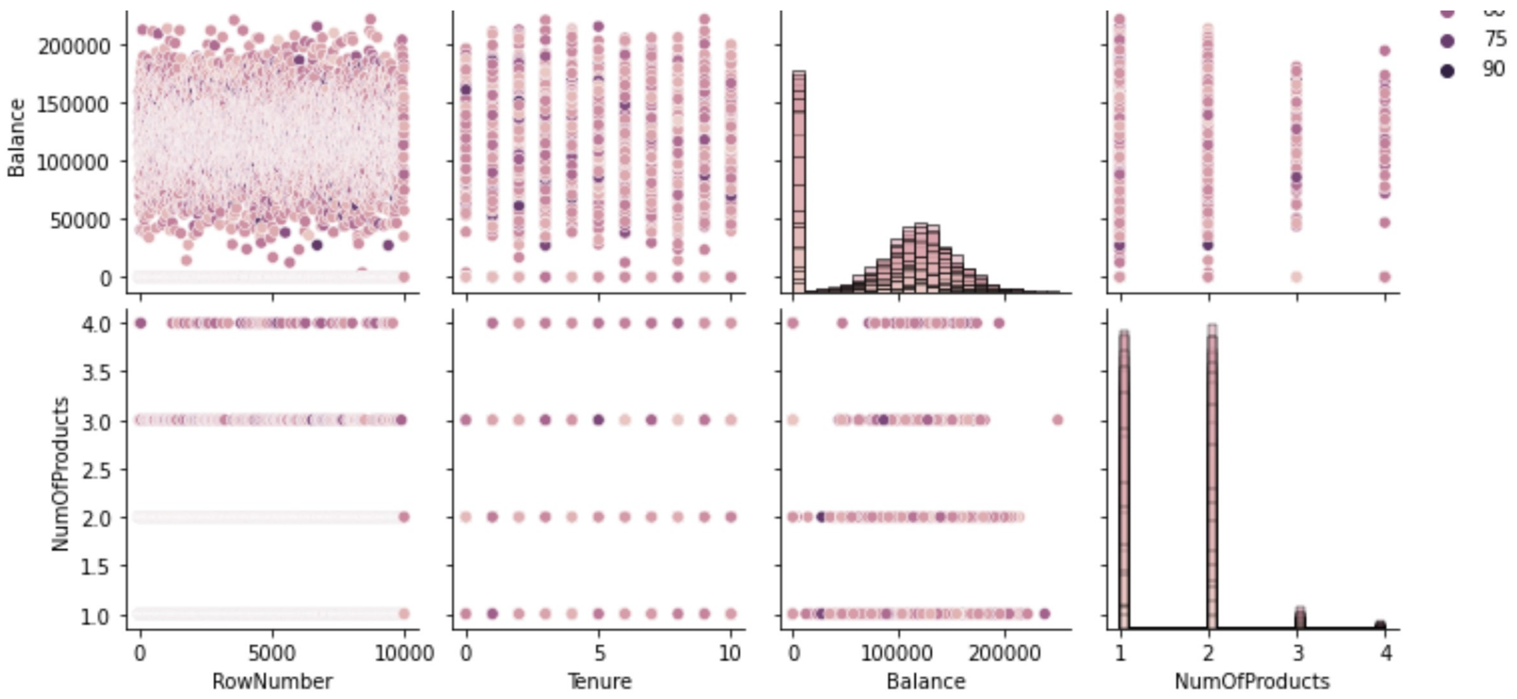
```
<seaborn.axisgrid.PairGrid at 0x7f8c94cb01d0>
```



```
sns.pairplot(data=df[["RowNumber","Age","Tenure","Balance","NumOfProducts"]], hue="Age", diag_kind="hist")
```

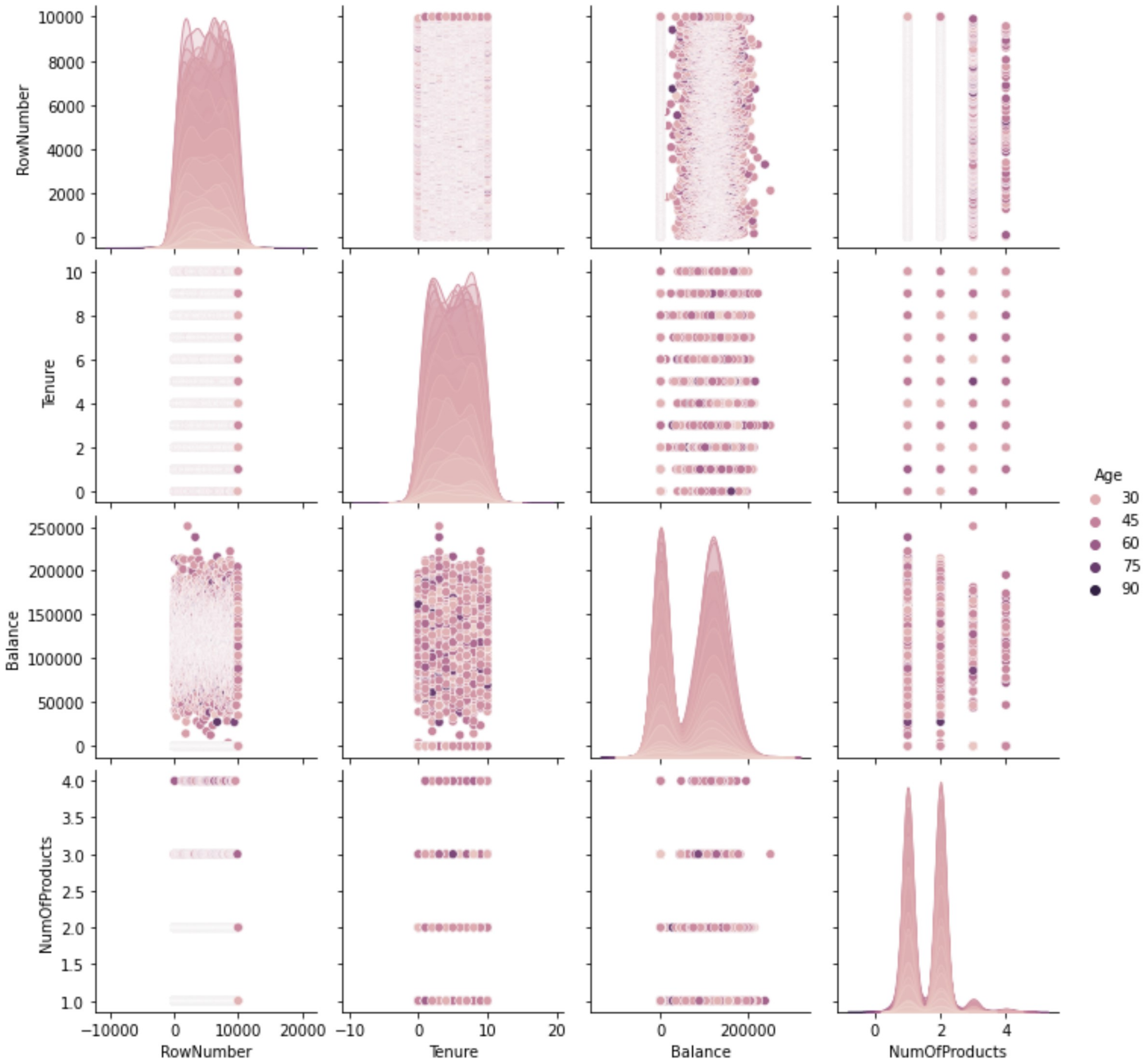
```
<seaborn.axisgrid.PairGrid at 0x7f8c93e736d0>
```





```
sns.pairplot(data=df[["RowNumber","Age","Tenure","Balance","NumOfProducts"]], hue="Age")
```

```
<seaborn.axisgrid.PairGrid at 0x7f8c91b68a10>
```



4. Perform descriptive statistics on the dataset

```
df.describe()
```

	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActive
count	10000.00000	1.000000e+04	10000.000000	10000.000000	10000.000000	10000.000000	10000.000000	10000.00000	10000.0
mean	5000.50000	1.569094e+07	650.528800	38.921800	5.012800	76485.889288	1.530200	0.70550	0.5
std	2886.89568	7.193619e+04	96.653299	10.487806	2.892174	62397.405202	0.581654	0.45584	0.4
min	1.00000	1.556570e+07	350.000000	18.000000	0.000000	0.000000	1.000000	0.00000	0.0
25%	2500.75000	1.562853e+07	584.000000	32.000000	3.000000	0.000000	1.000000	0.00000	0.0
50%	5000.50000	1.569074e+07	652.000000	37.000000	5.000000	97198.540000	1.000000	1.00000	1.0

75%	7500.25000	1.575323e+07	718.000000	44.000000	7.000000	127644.240000	2.000000	1.00000	1.(
max	10000.00000	1.581569e+07	850.000000	92.000000	10.000000	250898.090000	4.000000	1.00000	1.(

5. Handle the Missing values.

```
data=pd.DataFrame({"a":[1,2,np.nan],"b":[1,np.nan,np.nan],"c":[1,2,4]})
data
```

	a	b	c
0	1.0	1.0	1
1	2.0	NaN	2
2	NaN	NaN	4

```
data.isnull().any()
```

```
a     True
b     True
c    False
dtype: bool
```

```
data.isnull().sum()
```

```
a    1
b    2
c    0
dtype: int64
```

```
data.fillna(value = "S")
```

	a	b	c
0	1.0	1.0	1
1	2.0	S	2
2	S	S	4

```
data["a"].mean()
```

```
1.5
```

```
data["a"].median()
```

```
1.5
```

6. Find the outliers and replace the outliers

```
outliers=df.quantile(q=(0.25,0.75))
```

```
outliers
```

	RowNumber	CustomerId	CreditScore	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	EstimatedSalary
0.25	2500.75	15628528.25	584.0	32.0	3.0	0.00	1.0	0.0	0.0	51002.1100
0.75	7500.25	15753233.75	718.0	44.0	7.0	127644.24	2.0	1.0	1.0	149388.2475

```
aaa=outliers.loc[0.75]-outliers.loc[0.25]
```

```
aaa
```

```
RowNumber            4999.5000
CustomerId         124705.5000
CreditScore           134.0000
Age                    12.0000
```

```
    Age                    12.0000
    Tenure                  4.0000
    Balance            127644.2400
    NumOfProducts           1.0000
    HasCrCard               1.0000
    IsActiveMember          1.0000
    EstimatedSalary     98386.1375
    Exited                  0.0000
    dtype: float64
```

```
low = outliers.loc[0.25] - 1.5*aaa
```

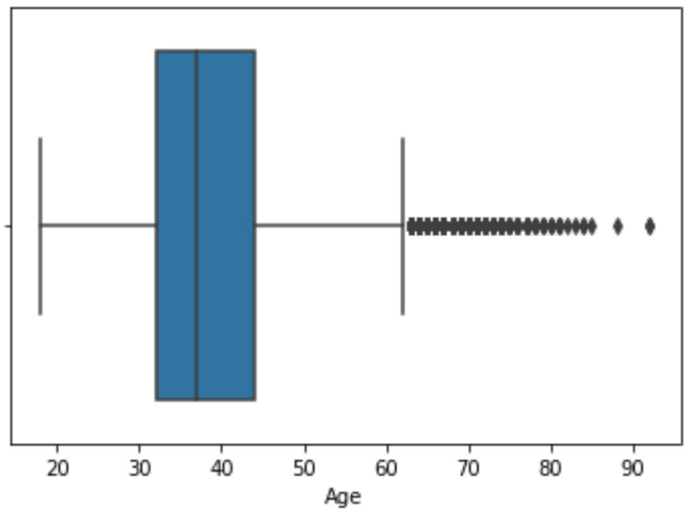
```
low
```

```
    RowNumber         -4.998500e+03
    CustomerId         1.544147e+07
    CreditScore        3.830000e+02
    Age                1.400000e+01
    Tenure            -3.000000e+00
    Balance           -1.914664e+05
    NumOfProducts     -5.000000e-01
    HasCrCard         -1.500000e+00
    IsActiveMember    -1.500000e+00
    EstimatedSalary   -9.657710e+04
    Exited             0.000000e+00
    dtype: float64
```

```
high = outliers.loc[0.75] + 1.5 * aaa
high
```

```
    RowNumber          1.499950e+04
    CustomerId         1.594029e+07
    CreditScore        9.190000e+02
    Age                6.200000e+01
    Tenure             1.300000e+01
    Balance            3.191106e+05
    NumOfProducts      3.500000e+00
    HasCrCard          2.500000e+00
    IsActiveMember     2.500000e+00
    EstimatedSalary    2.969675e+05
    Exited             0.000000e+00
    dtype: float64
```

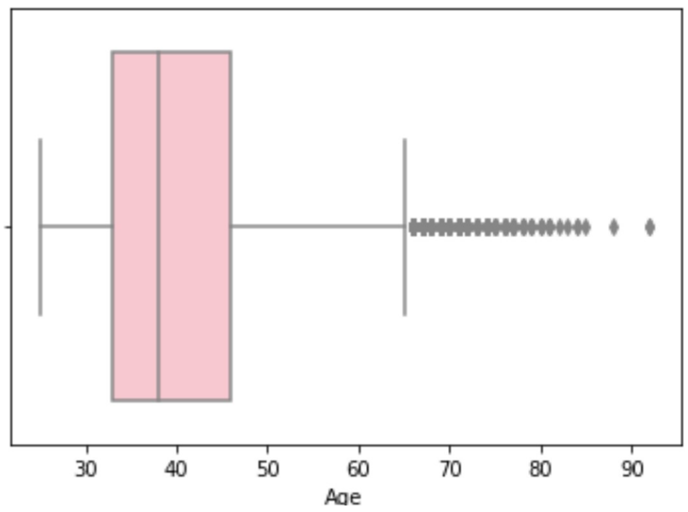
```
sns.boxplot(df['Age']);
```



```
df["Age"]=np.where(df["Age"]<25,50,df["Age"])
```

```
sns.boxplot(df["Age"],color='pink')
```

```
    <matplotlib.axes._subplots.AxesSubplot at 0x7f8c8d6033d0>
```



7. Check for Categorical columns and perform encoding.

```
df.head(4)
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveM
0	1	15634602	Hargrave	619	France	Female	42	2	0.00	1	1	
1	2	15647311	Hill	608	Spain	Female	41	1	83807.86	1	0	
2	3	15619304	Onio	502	France	Female	42	8	159660.80	3	1	
3	4	15701354	Boni	699	France	Female	39	1	0.00	2	0	

```
df["Gender"].replace({"Female":0,"Male":1},inplace = True)
df["Geography"].replace({"France":1,"Spain":2,"Germany":3},inplace = True)
df["Gender"].replace({"Female":0,"Male":1},inplace = True)
df["Geography"].replace({"France":1,"Spain":2,"Germany":3},inplace = True)
```

```
df.head(4)
```

	RowNumber	CustomerId	Surname	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveM
0	1	15634602	Hargrave	619	1	0	42	2	0.00	1	1	
1	2	15647311	Hill	608	2	0	41	1	83807.86	1	0	
2	3	15619304	Onio	502	1	0	42	8	159660.80	3	1	
3	4	15701354	Boni	699	1	0	39	1	0.00	2	0	

8. Split the data into dependent and independent variables.

```
y = df["Surname"]
x=df.drop(columns=["Surname"],axis=1)
x.head()
```

	RowNumber	CustomerId	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsActiveMember	Es
0	1	15634602	619	1	0	42	2	0.00	1	1	1	
1	2	15647311	608	2	0	41	1	83807.86	1	0	1	
2	3	15619304	502	1	0	42	8	159660.80	3	1	0	
3	4	15701354	699	1	0	39	1	0.00	2	0	0	
4	5	15737888	850	2	0	43	2	125510.82	1	1	1	

9. Scale the independent variables

```
names=x.columns
names
```

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

```
from sklearn.preprocessing import scale
X=scale(x)
X
```

```
array([[-1.73187761, -0.78321342, -0.32622142, ...,  0.97024255,
         0.02188649,  1.97716468],
       [-1.7315312 , -0.60653412, -0.44003595, ...,  0.97024255,
         0.21653375, -0.50577476],
       [-1.73118479, -0.99588476, -1.53679418, ..., -1.03067011,
         0.2406869 ,  1.97716468],
       ...,
       [ 1.73118479, -1.47928179,  0.60498839, ...,  0.97024255,
       [ 1.73118479, -1.47928179,  0.60498839, ...,  0.97024255,
        -1.00864308,  1.97716468],
       [ 1.7315312 , -0.11935577,  1.25683526, ..., -1.03067011,
        -0.12523071,  1.97716468],
       [ 1.73187761, -0.87055909,  1.46377078, ..., -1.03067011,
        -1.07636976, -0.50577476]])
```

```
x = pd.DataFrame(X,columns = names )
x
```

	RowNumber	CustomerId	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsAct
0	-1.731878	-0.783213	-0.326221	-0.902587	-1.095988	0.179622	-1.041760	-1.225848	-0.911583	0.646092	
1	-1.731531	-0.606534	-0.440036	0.301665	-1.095988	0.080092	-1.387538	0.117350	-0.911583	-1.547768	
2	-1.731185	-0.995885	-1.536794	-0.902587	-1.095988	0.179622	1.032908	1.333053	2.527057	0.646092	
3	-1.730838	0.144767	0.501521	-0.902587	-1.095988	-0.118968	-1.387538	-1.225848	0.807737	-1.547768	
4	-1.730492	0.652659	2.063884	0.301665	-1.095988	0.279152	-1.041760	0.785728	-0.911583	0.646092	
...	...	...	...	...	...	...	...	...	...	...	
9995	1.730492	-1.177652	1.246488	-0.902587	0.912419	-0.118968	-0.004426	-1.225848	0.807737	0.646092	
9996	1.730838	-1.682806	-1.391939	-0.902587	0.912419	-0.517088	1.724464	-0.306379	-0.911583	0.646092	
9997	1.731185	-1.479282	0.604988	-0.902587	-1.095988	-0.417558	0.687130	-1.225848	-0.911583	-1.547768	
9998	1.731531	-0.119356	1.256835	1.505917	0.912419	0.179622	-0.695982	-0.022608	0.807737	0.646092	
9999	1.731878	-0.870559	1.463771	-0.902587	-1.095988	-1.213798	-0.350204	0.859965	-0.911583	0.646092	

10000 rows × 13 columns

10. Split the data into training and testing

```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.2,random_state=0)
x_train.head()
```

	RowNumber	CustomerId	CreditScore	Geography	Gender	Age	Tenure	Balance	NumOfProducts	HasCrCard	IsAct
7389	0.827747	-0.195066	0.170424	0.301665	-1.095988	-0.616618	-0.004426	-1.225848	0.807737	0.646092	
9275	1.481077	0.810821	-2.312802	1.505917	0.912419	0.179622	-1.387538	-0.012892	-0.911583	0.646092	
2995	-0.694379	-1.507642	-1.195351	-0.902587	-1.095988	-1.114268	-1.041760	0.575076	-0.911583	0.646092	
5316	0.109639	1.243462	0.035916	0.301665	0.912419	-0.019438	-0.004426	0.467955	-0.911583	0.646092	
356	-1.608556	-1.100775	2.063884	0.301665	-1.095988	1.672571	1.032908	0.806010	0.807737	0.646092	

```
x_train.shape,y_train.shape,x_test.shape,y_test.shape
```

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