In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn import svm
from sklearn.metrics import confusion_matrix,classification_report
from sklearn.neighbors import KNeighborsClassifier
```

In [2]:
```
loan= pd.read_csv('C:\\Users\\LENOVO\\Documents\\loan.csv')
```

In [3]:
```
loan.head(10)
```

Out[3]:

	Id	Income	Age	Experience	Married/Single	House_Ownership	Car_Ownership	CURRENT_JOI
0	1	1303834	23	3	single	rented	no	
1	2	7574516	40	10	single	rented	no	
2	3	3991815	66	4	married	rented	no	
3	4	6256451	41	2	single	rented	yes	
4	5	5768871	47	11	single	rented	no	
5	6	6915937	64	0	single	rented	no	
6	7	3954973	58	14	married	rented	no	
7	8	1706172	33	2	single	rented	no	
8	9	7566849	24	17	single	rented	yes	
9	10	8964846	23	12	single	rented	no	

In [4]:
```
loan.tail()
```

Out[4]:

	Id	Income	Age	Experience	Married/Single	House_Ownership	Car_Ownership	CUR
251995	251996	8154883	43	13	single	rented	no	
251996	251997	2843572	26	10	single	rented	no	
251997	251998	4522448	46	7	single	rented	no	
251998	251999	6507128	45	0	single	rented	no	
251999	252000	9070230	70	17	single	rented	no	

In [5]:
```
loan.shape
```

Out[5]:
```
(252000, 10)
```

In [6]:
```
loan.isnull()
```

Out[6]:

	Id	Income	Age	Experience	Married/Single	House_Ownership	Car_Ownership	CURR
0	False	False	False	False	False	False	False	
1	False	False	False	False	False	False	False	
2	False	False	False	False	False	False	False	
3	False	False	False	False	False	False	False	
4	False	False	False	False	False	False	False	
...	...	...	...	...	...	...	...	...
251995	False	False	False	False	False	False	False	
251996	False	False	False	False	False	False	False	
251997	False	False	False	False	False	False	False	
251998	False	False	False	False	False	False	False	
251999	False	False	False	False	False	False	False	

252000 rows × 10 columns

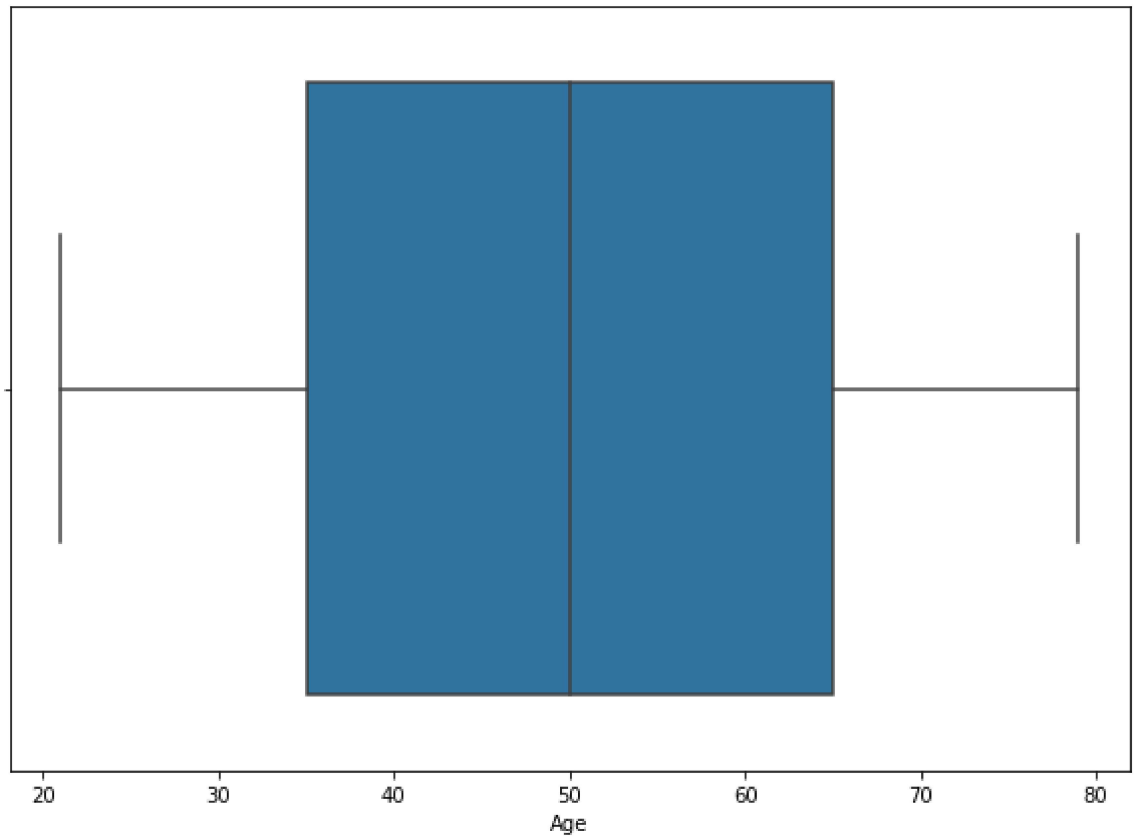
In [7]:
```
loan.describe()
```

Out[7]:

	Id	Income	Age	Experience	CURRENT_JOB_YRS	CURRENT
count	252000.000000	2.520000e+05	252000.000000	252000.000000	252000.000000	
mean	126000.500000	4.997117e+06	49.954071	10.084437	6.333877	
std	72746.278255	2.878311e+06	17.063855	6.002590	3.647053	
min	1.000000	1.031000e+04	21.000000	0.000000	0.000000	
25%	63000.750000	2.503015e+06	35.000000	5.000000	3.000000	
50%	126000.500000	5.000694e+06	50.000000	10.000000	6.000000	
75%	189000.250000	7.477502e+06	65.000000	15.000000	9.000000	
max	252000.000000	9.999938e+06	79.000000	20.000000	14.000000	

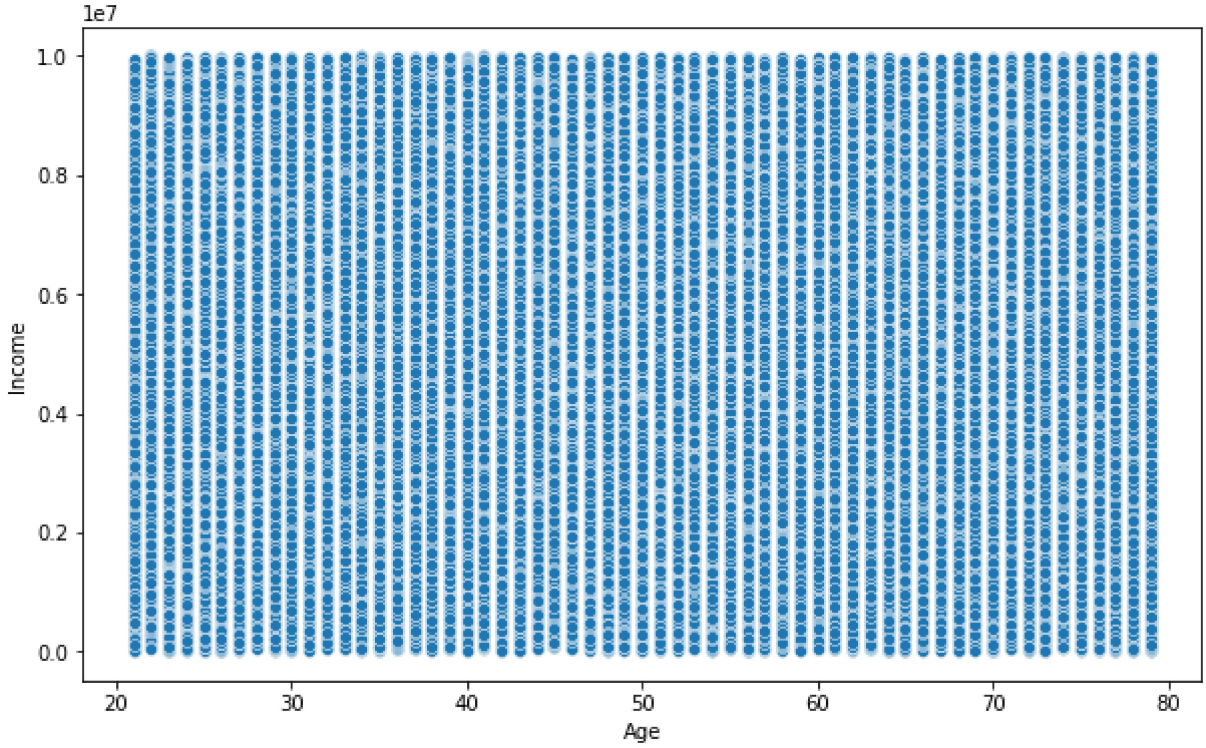
In [8]:
```
plt.figure(figsize=(10,7))
sns.boxplot(x=loan['Age'])
```

Out[8]: <AxesSubplot:xlabel='Age'>



In [9]:
```
plt.figure(figsize=(10,6))
sns.scatterplot(x=loan['Age'],y=loan['Income'])
```

Out[9]:
```
<AxesSubplot:xlabel='Age', ylabel='Income'>
```



In [10]:
```
loan.Risk_Flag.value_counts()
```

Out[10]:
```
0    221004
1     30996
Name: Risk_Flag, dtype: int64
```

In [11]:
```
loan['Married/Single'].value_counts()
```

Out[11]:
```
single     226272
married     25728
Name: Married/Single, dtype: int64
```

In [12]:
```
loan['House_Ownership'].value_counts()
```

Out[12]:
```
rented          231898
owned            12918
norent_noown      7184
Name: House_Ownership, dtype: int64
```

In [13]:
```
loan['Car_Ownership'].value_counts()
```

Out[13]:
```
no     176000
yes     76000
Name: Car_Ownership, dtype: int64
```

In [14]:
```
loan['Married/Single'].replace({"single":1,"married":2},inplace=True)
```

In [15]:
```
loan['House_Ownership'].replace({"rented":2,"owned":2,"norent_noown":3},inplace=1
```

In [16]:
```
loan['Car_Ownership'].replace({"no":1,"yes":2},inplace=True)
```

In [17]:
```
loan
```

Out[17]:

	Id	Income	Age	Experience	Married/Single	House_Ownership	Car_Ownership	CUR
0	1	1303834	23	3	1	2	1	
1	2	7574516	40	10	1	2	1	
2	3	3991815	66	4	2	2	1	
3	4	6256451	41	2	1	2	2	
4	5	5768871	47	11	1	2	1	
...	...	...	...	...	...	...	...	...
251995	251996	8154883	43	13	1	2	1	
251996	251997	2843572	26	10	1	2	1	
251997	251998	4522448	46	7	1	2	1	
251998	251999	6507128	45	0	1	2	1	
251999	252000	9070230	70	17	1	2	1	

252000 rows × 10 columns

In [18]:
```
x=loan.drop(['Risk_Flag'],axis=1)
```

In [19]:
```
x
```

Out[19]:

	Id	Income	Age	Experience	Married/Single	House_Ownership	Car_Ownership	CUR
0	1	1303834	23	3	1	2	1	
1	2	7574516	40	10	1	2	1	
2	3	3991815	66	4	2	2	1	
3	4	6256451	41	2	1	2	2	
4	5	5768871	47	11	1	2	1	
...	...	...	...	...	...	...	...	
251995	251996	8154883	43	13	1	2	1	
251996	251997	2843572	26	10	1	2	1	
251997	251998	4522448	46	7	1	2	1	
251998	251999	6507128	45	0	1	2	1	
251999	252000	9070230	70	17	1	2	1	

252000 rows × 9 columns

In [20]:
```
y=loan['Risk_Flag']
```

In [21]:
```
y
```

Out[21]:
```
0         0
1         0
2         0
3         1
4         1
         ..
251995    0
251996    0
251997    0
251998    0
251999    0
Name: Risk_Flag, Length: 252000, dtype: int64
```

In [22]:
```
#TRAINING AND TESTING OUR DATASET
x_train,x_test,y_train,y_test=train_test_split(x,y,train_size=0.25,random_state=4
```

In [23]:
```
#USING DECISION TREE CLASSIFIER ALGORITHM
dtc=DecisionTreeClassifier(random_state=45)
```

In [24]:
```
dtc.fit(x_train,y_train)
```

Out[24]:
```
DecisionTreeClassifier(random_state=45)
```

In [25]:
```
dtc_pred = dtc.predict(x_test)
```

In [26]:
```
dtc_pred
```

Out[26]:
```
array([0, 1, 1, ..., 0, 0, 0], dtype=int64)
```

In [27]:
```
#TESTING THE ACCURACY OF THE MODEL
print(confusion_matrix(y_test,dtc_pred))
```

```
[[146204  19447]
 [ 17463   5886]]
```

In [28]:
```
print(classification_report(y_test,dtc_pred))
```

```
              precision    recall  f1-score   support

           0       0.89      0.88      0.89    165651
           1       0.23      0.25      0.24     23349

    accuracy                           0.80    189000
   macro avg       0.56      0.57      0.56    189000
weighted avg       0.81      0.80      0.81    189000
```

In [29]:
```
#USING RANDOM FOREST CLASSIFIER ALGORITHM
rfc=RandomForestClassifier(n_estimators=200)
```

In [30]:
```
rfc.fit(x_train,y_train)
```

Out[30]:
```
RandomForestClassifier(n_estimators=200)
```

In [31]:
```
rfc_pred = rfc.predict(x_test)
```

In [32]:
```
rfc_pred
```

Out[32]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [33]:
```
#TO SEE HOW THE MODEL PERFORM
print(classification_report(y_test,rfc_pred))
```

```
              precision    recall  f1-score   support

           0       0.90      0.99      0.94    165651
           1       0.76      0.23      0.35     23349

    accuracy                           0.90    189000
   macro avg       0.83      0.61      0.65    189000
weighted avg       0.88      0.90      0.87    189000
```

In [34]:
```
#USING KNEAREST NIEGHBOR  ALGORITHM
knn=KNeighborsClassifier(n_neighbors=5)
```

In [35]:
```
knn.fit(x_train,y_train)
```

Out[35]:
```
KNeighborsClassifier()
```

In [36]:
```
knn_pred=knn.predict(x_test)
```

In [37]:
```
knn_pred
```

Out[37]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [38]:
```
# TO SEE THE ACCURACY OF THE MODEL
print(classification_report(y_test,knn_pred))
```

```
              precision    recall  f1-score   support

           0       0.88      0.98      0.92    165651
           1       0.23      0.05      0.09     23349

    accuracy                           0.86    189000
   macro avg       0.56      0.51      0.51    189000
weighted avg       0.80      0.86      0.82    189000
```

In [39]:
```
# USING VOTING ENSEMBLE TO DECIDE THE BEST MODEL
from sklearn.ensemble import VotingClassifier
```

In [40]:
```
estimators=[('Decision',dtc), ('Random',rfc),('KNeighbors',knn)]
```

In [41]:
```
VC= VotingClassifier(estimators=estimators,voting='soft')
```

In [42]:
```
VC.fit(x_train,y_train)
```

Out[42]:
```
VotingClassifier(estimators=[('Decision',
                              DecisionTreeClassifier(random_state=45)),
                             ('Random',
                              RandomForestClassifier(n_estimators=200)),
                             ('KNeighbors', KNeighborsClassifier())],
                 voting='soft')
```

In [43]:
```
vc_pred= VC.predict(x_test)
```

In [44]:
```
vc_pred
```

Out[44]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [45]:
```
print(classification_report(y_test,vc_pred))
```

```
              precision    recall  f1-score   support

           0       0.89      0.98      0.93    165651
           1       0.49      0.15      0.23     23349

    accuracy                           0.88    189000
   macro avg       0.69      0.56      0.58    189000
weighted avg       0.84      0.88      0.85    189000
```

In [46]:
```
#USING BAGGING ENSEMBLE
from sklearn.ensemble import BaggingClassifier
```

In [47]:
```
BC= BaggingClassifier(base_estimator=dtc,n_estimators=10)
```

In [48]:
```
BC.fit(x_train,y_train)
```

Out[48]:
```
BaggingClassifier(base_estimator=DecisionTreeClassifier(random_state=45))
```

In [49]:
```
bc_pred=BC.predict(x_test)
```

In [50]:
```
bc_pred
```

Out[50]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [51]:
```
print(classification_report(y_test,bc_pred))
```

```
              precision    recall  f1-score   support

           0       0.88      0.98      0.93    165651
           1       0.36      0.06      0.11     23349

    accuracy                           0.87    189000
   macro avg       0.62      0.52      0.52    189000
weighted avg       0.82      0.87      0.83    189000
```

In [52]:
```
# USING STACKING ENSEMBLE
from sklearn.ensemble import StackingClassifier
```

In [53]:
```
SR= StackingClassifier(estimators=estimators,final_estimator=dtc)
```

In [54]:
```
SR.fit(x_train,y_train)
```

Out[54]:
```
StackingClassifier(estimators=[('Decision',
                                DecisionTreeClassifier(random_state=45)),
                               ('Random',
                                RandomForestClassifier(n_estimators=200)),
                               ('KNeighbors', KNeighborsClassifier())],
                   final_estimator=DecisionTreeClassifier(random_state=45))
```

In [55]:
```
sr_pred=SR.predict(x_test)
```

In [56]:
```
sr_pred
```

Out[56]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [57]:
```
print(classification_report(y_test,sr_pred))
```

```
              precision    recall  f1-score   support

           0       0.91      0.98      0.94    165651
           1       0.68      0.27      0.39     23349

    accuracy                           0.89    189000
   macro avg       0.79      0.63      0.67    189000
weighted avg       0.88      0.89      0.87    189000
```

In [58]:
```
#USING GRADIENT BOOSTING CLASSIFIER
from sklearn.ensemble import GradientBoostingClassifier
```

In [59]:
```
GBC=GradientBoostingClassifier(n_estimators=100)
```

In [60]:
```
GBC.fit(x_train,y_train)
```

Out[60]:
```
GradientBoostingClassifier()
```

In [61]:
```
gbc_pred=GBC.predict(x_test)
```

In [62]:
```
gbc_pred
```

Out[62]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [63]:
```
print(classification_report(y_test,gbc_pred))
```

```
              precision    recall  f1-score   support

           0       0.88      1.00      0.93    165651
           1       0.71      0.00      0.00     23349

    accuracy                           0.88    189000
   macro avg       0.79      0.50      0.47    189000
weighted avg       0.86      0.88      0.82    189000
```

In [64]:
```
# USING VOTING ENSEMBLE TO DECIDE THE BEST MODEL
from sklearn.ensemble import VotingClassifier
```

In [67]:
```
estimators=[('Voting',VC), ('Bagging',BC),('Stacking',SR),('Gradient',GBC)]
```

In [68]:
```
VC= VotingClassifier(estimators=estimators,voting='hard')
```

In [69]:
```
VC.fit(x_train,y_train)
```

Out[69]:
```
VotingClassifier(estimators=[('Voting',
                              VotingClassifier(estimators=[('Decision',
                                                            DecisionTreeClassif
ier(random_state=45)),
                                                           ('Random',
                                                            RandomForestClassif
ier(n_estimators=200)),
                                                           ('KNeighbors',
                                                            KNeighborsClassifie
r())],
                                                voting='soft')),
                             ('Bagging',
                              BaggingClassifier(base_estimator=DecisionTreeClas
sifier(random_state=45))),
                             ('Stacking',
                              StackingClassifier(estimators=[('Decision',
                                                              DecisionTreeClass
ifier(random_state=45)),
                                                             ('Random',
                                                              RandomForestClass
ifier(n_estimators=200)),
                                                             ('KNeighbors',
                                                              KNeighborsClassif
ier())],
                                                 final_estimator=DecisionTreeCl
assifier(random_state=45))),
                             ('Gradient', GradientBoostingClassifier())])
```

In [71]:
```
final_pred=VC.predict(x_test)
```

In [72]:
```
final_pred
```

Out[72]:
```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [73]:
```
print(classification_report(y_test,final_pred))
```

```
              precision    recall  f1-score   support

           0       0.88      1.00      0.94    165651
           1       0.84      0.03      0.05     23349

    accuracy                           0.88    189000
   macro avg       0.86      0.51      0.50    189000
weighted avg       0.87      0.88      0.83    189000
```

In [77]:
```
# pickle to save model
import pickle
```

In [78]:
```
with open('loan.plk','wb') as f:
    pickle.dump(loan, f, protocol=pickle.HIGHEST_PROTOCOL)
```

In [ ]: