Credit Card

June 10, 2020

[1]:
```python
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.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import BaggingClassifier
from sklearn import svm
from sklearn.neighbors import KNeighborsClassifier
```

[2]:
```python
credit = pd.read_csv('Credit_Card.csv')
```

[3]:
```python
credit.head()
```

[3]:

	clientid	income	age	loan	LTI	default10yr
0	1	66155.93	59.02	8106.53	0.123	0
1	2	34415.15	48.12	6564.75	0.191	0
2	3	57317.17	63.11	8020.95	0.140	0
3	4	42709.53	45.75	6103.64	0.143	0
4	5	66952.69	18.58	8770.10	0.131	1

[4]:
```python
credit.shape
```

[4]:
```
(2000, 6)
```

[5]:
```python
credit.info()
```

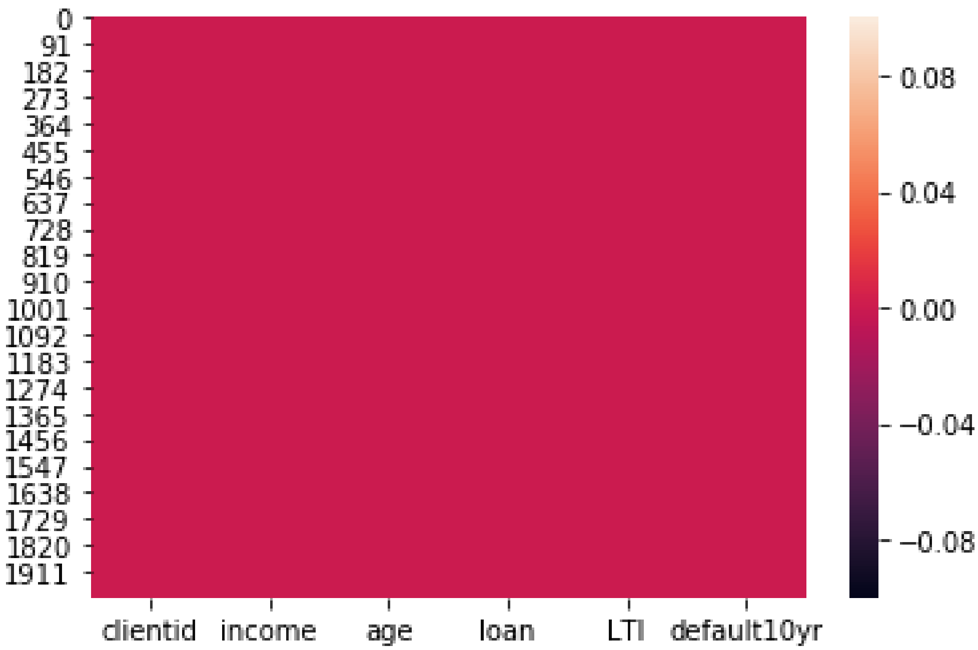
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2000 entries, 0 to 1999
Data columns (total 6 columns):
clientid       2000 non-null int64
income         2000 non-null float64
age            2000 non-null float64
loan           2000 non-null float64
```

```
LTI            2000 non-null float64
default10yr    2000 non-null int64
dtypes: float64(4), int64(2)
memory usage: 93.8 KB
```

[6]:
```
credit.isnull().sum()
```

[6]:
```
clientid       0
income         0
age            0
loan           0
LTI            0
default10yr    0
dtype: int64
```

[7]:
```
sns.heatmap(credit.isnull());
```



[8]:
```
credit.default10yr.value_counts()
```

[8]:
```
0    1717
1     283
Name: default10yr, dtype: int64
```

[9]:
```
credit.head()
```

[9]:
```
   clientid    income    age     loan    LTI  default10yr
0         1  66155.93  59.02  8106.53  0.123            0
1         2  34415.15  48.12  6564.75  0.191            0
```

```
2          3  57317.17  63.11  8020.95  0.140            0
3          4  42709.53  45.75  6103.64  0.143            0
4          5  66952.69  18.58  8770.10  0.131            1
```

[10]:
```python
credit = credit.drop('clientid',axis=1)
```

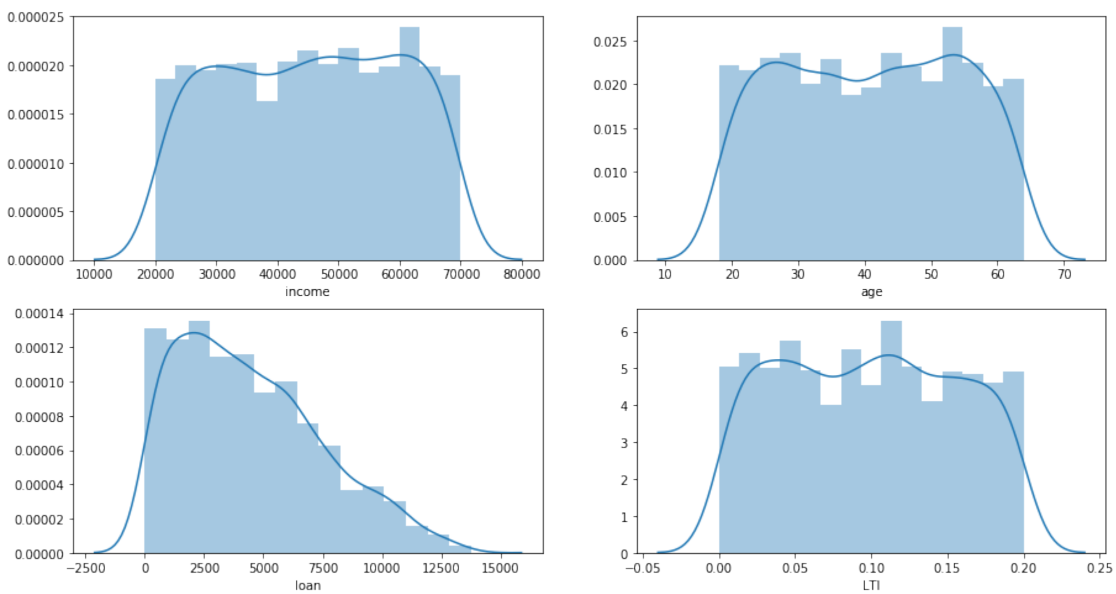
[11]:
```python
credit.head()
```

[11]:

	income	age	loan	LTI	default10yr
0	66155.93	59.02	8106.53	0.123	0
1	34415.15	48.12	6564.75	0.191	0
2	57317.17	63.11	8020.95	0.140	0
3	42709.53	45.75	6103.64	0.143	0
4	66952.69	18.58	8770.10	0.131	1

[12]:
```python
plt.figure(figsize=(15,8))
plt.subplot(2,2,1)
sns.distplot(credit.income, bins=15);
plt.subplot(2,2,2)
sns.distplot(credit.age, bins=15);
plt.subplot(2,2,3)
sns.distplot(credit.loan, bins=15);
plt.subplot(2,2,4)
sns.distplot(credit.LTI, bins=15);
```

```
/home/nbuser/anaconda3_501/lib/python3.6/site-
packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence
for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of
`arr[seq]`. In the future this will be interpreted as an array index,
`arr[np.array(seq)]`, which will result either in an error or a different
result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

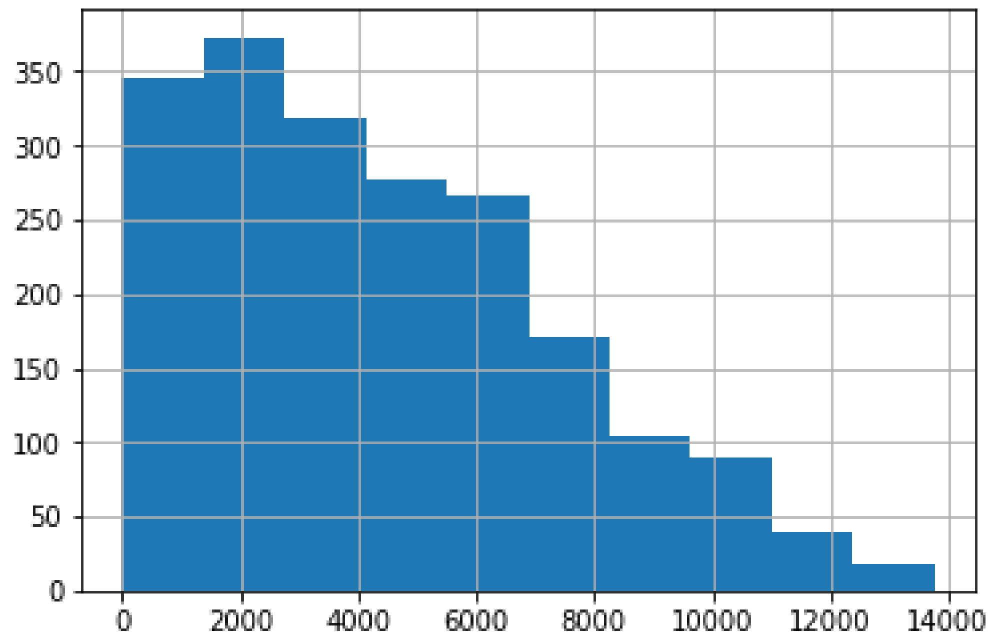


[13]:
```
credit.describe()
```

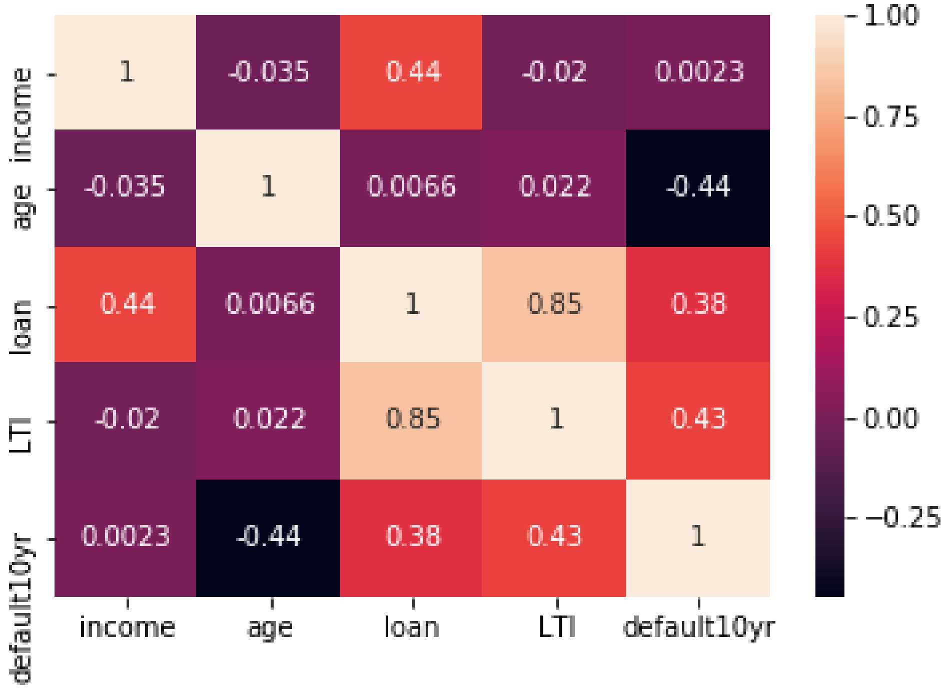
[13]:

	income	age	loan	LTI	default10yr
count	2000.000000	2000.000000	2000.000000	2000.000000	2000.000000
mean	45331.599930	40.927245	4444.369635	0.098392	0.141500
std	14326.327142	13.262516	3045.409995	0.057619	0.348624
min	20014.490000	18.060000	1.380000	0.000000	0.000000
25%	32796.457500	29.060000	1939.705000	0.048000	0.000000
50%	45789.120000	41.380000	3974.720000	0.099500	0.000000
75%	57791.285000	52.600000	6432.407500	0.148000	0.000000
max	69995.690000	63.970000	13766.050000	0.200000	1.000000

[14]:
```
credit.loan.hist();
```



[15]:
```
sns.heatmap(credit.corr(),annot=True);
```



[16]:
```
credit.head()
```

[16]:
```
     income    age     loan    LTI  default10yr
0  66155.93  59.02  8106.53  0.123            0
1  34415.15  48.12  6564.75  0.191            0
2  57317.17  63.11  8020.95  0.140            0
3  42709.53  45.75  6103.64  0.143            0
4  66952.69  18.58  8770.10  0.131            1
```

[17]:
```
y = credit['default10yr']
X = credit.drop(['default10yr'], axis=1)
```

[18]:
```
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,␣
 ↪random_state=100)
```

[19]:
```
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

0.1 Logistic Model

[20]:
```
model_logistic = LogisticRegression()
```

[21]:
```
model_logistic.fit(X_train,y_train)
```

```
/home/nbuser/anaconda3_501/lib/python3.6/site-
packages/sklearn/linear_model/logistic.py:433: FutureWarning: Default solver
```

```
will be changed to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
```

[21]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='warn',
          tol=0.0001, verbose=0, warm_start=False)
```

[22]:
```
y_pred_logistic = model_logistic.predict(X_test)
```

[23]:
```
print(confusion_matrix(y_pred_logistic, y_test))
```

```
[[320   9]
 [ 11  60]]
```

[24]:
```
classification_report(y_pred_logistic, y_test)
```

[24]:
```
'              precision    recall  f1-score   support\n\n           0
0.97      0.97      0.97       329\n           1       0.87      0.85      0.86
71\n\n   micro avg       0.95      0.95      0.95       400\n   macro avg
0.92      0.91      0.91       400\nweighted avg       0.95      0.95      0.95
400\n'
```

[25]:
```
print(classification_report(y_pred_logistic, y_test))
```

```
              precision    recall  f1-score   support

           0       0.97      0.97      0.97       329
           1       0.87      0.85      0.86        71

   micro avg       0.95      0.95      0.95       400
   macro avg       0.92      0.91      0.91       400
weighted avg       0.95      0.95      0.95       400
```

[26]:
```
accuracy_score(y_pred_logistic, y_test)
```

[26]:
```
0.95
```

[27]:
```
print("Accuracy of Logistic Model is",(accuracy_score(y_pred_logistic,␣
 ↪y_test)*100),"%")
```

```
Accuracy of Logistic Model is 95.0 %
```

0.1.1 Accuracy of Logistic Model is 95.0%

0.2 Decision Tree Model

[28]:
```
model_decision = DecisionTreeClassifier()
```

[29]:
```
model_decision.fit(X_train,y_train)
```

[29]:
```
DecisionTreeClassifier(class_weight=None, criterion='gini', max_depth=None,
            max_features=None, max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, presort=False, random_state=None,
            splitter='best')
```

[30]:
```
y_pred_decision = model_decision.predict(X_test)
```

[31]:
```
print(classification_report(y_pred_decision, y_test))
```

```
              precision    recall  f1-score   support

           0       1.00      0.99      1.00       333
           1       0.97      1.00      0.99        67

   micro avg       0.99      0.99      0.99       400
   macro avg       0.99      1.00      0.99       400
weighted avg       1.00      0.99      1.00       400
```

[32]:
```
confusion_matrix(y_pred_decision, y_test)
```

[32]:
```
array([[331,   2],
       [  0,  67]])
```

[33]:
```
accuracy_score(y_pred_decision, y_test)
```

[33]:
```
0.995
```

[34]:
```
print("Accuracy of Decision Tree Model is",(accuracy_score(y_pred_decision,␣
 ↪y_test)*100),"%")
```

```
Accuracy of Decision Tree Model is 99.5 %
```

0.2.1 Accuracy of Decision Tree Model is 99.5%

0.3 Bagging Ensemble Model (To reduce Variance or Noise or Complexity)

[35]:
```
model_bagging = BaggingClassifier()
```

[36]:
```
model_bagging.fit(X_train, y_train)
```

[36]:
```
BaggingClassifier(base_estimator=None, bootstrap=True,
         bootstrap_features=False, max_features=1.0, max_samples=1.0,
```

```
            n_estimators=10, n_jobs=None, oob_score=False, random_state=None,
            verbose=0, warm_start=False)
```

[37]:
```python
y_pred_bagging = model_bagging.predict(X_test)
```

[38]:
```python
print(classification_report(y_pred_bagging, y_test))
```

```
              precision    recall  f1-score   support

           0       1.00      0.99      1.00       333
           1       0.97      1.00      0.99        67

   micro avg       0.99      0.99      0.99       400
   macro avg       0.99      1.00      0.99       400
weighted avg       1.00      0.99      1.00       400
```

[39]:
```python
print(confusion_matrix(y_pred_bagging, y_test))
```

```
[[331   2]
 [  0  67]]
```

[40]:
```python
accuracy_score(y_pred_bagging, y_test)
```

[40]: 0.995

[41]:
```python
print("Accuracy of Bagging Ensemble Model is",(accuracy_score(y_pred_bagging,␣
 ↪y_test)*100),"%")
```

```
Accuracy of Bagging Ensemble Model is 99.5 %
```

0.3.1 Accuracy of Bagging Ensemble Model is 99.50%

0.4 Random Forest Model

[42]:
```python
model_random = RandomForestClassifier(n_estimators=100)
```

[43]:
```python
model_random.fit(X_train, y_train)
```

[43]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=100, n_jobs=None,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

[44]:
```python
y_pred_random = model_random.predict(X_test)
```

[45]:
```python
print(classification_report(y_pred_random, y_test))
```

```
              precision    recall  f1-score   support

           0       1.00      0.99      1.00       333
           1       0.97      1.00      0.99        67

   micro avg       0.99      0.99      0.99       400
   macro avg       0.99      1.00      0.99       400
weighted avg       1.00      0.99      1.00       400
```

[46]:
```python
print(confusion_matrix(y_pred_random, y_test))
```

```
[[331   2]
 [  0  67]]
```

[47]:
```python
accuracy_score(y_pred_random, y_test)
```

[47]: 0.995

[48]:
```python
print("Accuracy of Random Forest Model is",(accuracy_score(y_pred_random,␣
↪y_test)*100),"%")
```

```
Accuracy of Random Forest Model is 99.5 %
```

0.4.1 Accuracy of Random Forest Model is 99.5 %

0.5 Support Vector Machine Model

[49]:
```python
model_svm = svm.SVC()
```

[50]:
```python
model_svm.fit(X_train,y_train)
```

[50]:
```
SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
  kernel='rbf', max_iter=-1, probability=False, random_state=None,
  shrinking=True, tol=0.001, verbose=False)
```

[51]:
```python
y_pred_svm = model_svm.predict(X_test)
```

[52]:
```python
print(classification_report(y_pred_svm, y_test))
```

```
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       331
           1       0.94      0.94      0.94        69

   micro avg       0.98      0.98      0.98       400
   macro avg       0.96      0.96      0.96       400
weighted avg       0.98      0.98      0.98       400
```

[53]:
```
print(confusion_matrix(y_pred_svm, y_test))
```

```
[[327   4]
 [  4  65]]
```

[54]:
```
accuracy_score(y_pred_svm, y_test)
```

[54]: 0.98

[55]:
```
print("Accuracy of Supprt vector Machine Model is",(accuracy_score(y_pred_svm,␣
↪y_test)*100),"%")
```

```
Accuracy of Supprt vector Machine Model is 98.0 %
```

0.5.1 Accuracy of Supprt vector Machine Model is 98.0 %

0.6 XG Boosting Ensemble Model

[56]:
```
!pip install xgboost
```

```
Requirement already satisfied: xgboost in
/home/nbuser/anaconda3_501/lib/python3.6/site-packages (1.1.1)
Requirement already satisfied: numpy in /home/nbuser/anaconda3_501/lib/python3.6
/site-packages (from xgboost) (1.16.2)
Requirement already satisfied: scipy in /home/nbuser/anaconda3_501/lib/python3.6
/site-packages (from xgboost) (1.1.0)
WARNING: You are using pip version 19.3.1; however, version 20.1.1 is
available.
You should consider upgrading via the 'pip install --upgrade pip' command.
```

[57]:
```
pip install --upgrade pip
```

```
The following command must be run outside of the IPython shell:

    $ pip install --upgrade pip

The Python package manager (pip) can only be used from outside of IPython.
Please reissue the `pip` command in a separate terminal or command prompt.

See the Python documentation for more information on how to install packages:

    https://docs.python.org/3/installing/
```

[58]:
```
import xgboost as xgb
from xgboost import XGBClassifier
```

[59]:
```
model_xgb = XGBClassifier()
```

[60]:
```
model_xgb.fit(X_train, y_train)
```

[60]:
```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=1, colsample_bytree=1, gamma=0, gpu_id=-1,
              importance_type='gain', interaction_constraints='',
              learning_rate=0.300000012, max_delta_step=0, max_depth=6,
              min_child_weight=1, missing=nan, monotone_constraints='()',
              n_estimators=100, n_jobs=0, num_parallel_tree=1,
              objective='binary:logistic', random_state=0, reg_alpha=0,
              reg_lambda=1, scale_pos_weight=1, subsample=1, tree_method='exact',
              validate_parameters=1, verbosity=None)
```

[61]:
```
y_pred_xgb = model_xgb.predict(X_test)
```

[62]:
```
print(classification_report(y_pred_xgb, y_test))
```

```
              precision    recall  f1-score   support

           0       1.00      0.99      1.00       333
           1       0.97      1.00      0.99        67

   micro avg       0.99      0.99      0.99       400
   macro avg       0.99      1.00      0.99       400
weighted avg       1.00      0.99      1.00       400
```

[63]:
```
print(confusion_matrix(y_pred_xgb, y_test))
```

```
[[331   2]
 [  0  67]]
```

[64]:
```
accuracy_score(y_pred_xgb, y_test)
```

[64]:
```
0.995
```

[65]:
```
print("Accuracy of XG Boost Model is",(accuracy_score(y_pred_xgb,␣
 ↪y_test)*100),"%")
```

```
Accuracy of XG Boost Model is 99.5 %
```

0.6.1 Accuracy of XG Boost Model is 99.5 %

0.7 K Nearest Neighbors Model

[66]:
```
model_knn = KNeighborsClassifier(n_neighbors = 20, p=2,  metric='euclidean')
```

[67]:
```
import math
math.sqrt(len(y_test))
```

[67]:
```
20.0
```

[68]:
```
model_knn.fit(X_train, y_train)
```

[68]:
```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='euclidean',
           metric_params=None, n_jobs=None, n_neighbors=20, p=2,
           weights='uniform')
```

[69]:
```
y_pred_knn = model_knn.predict(X_test)
```

[70]:
```
print(classification_report(y_pred_knn, y_test))
```

```
              precision    recall  f1-score   support

           0       1.00      0.98      0.99       338
           1       0.88      0.98      0.93        62

   micro avg       0.98      0.98      0.98       400
   macro avg       0.94      0.98      0.96       400
weighted avg       0.98      0.98      0.98       400
```

[71]:
```
print(confusion_matrix(y_pred_knn, y_test))
```

```
[[330   8]
 [  1  61]]
```

[72]:
```
accuracy_score(y_pred_knn, y_test)
```

[72]:
```
0.9775
```

[73]:
```
print("Accuracy of K Nearest Neighbors Model is",(accuracy_score(y_pred_knn,␣
 ↪y_test)*100),"%")
```

```
Accuracy of K Nearest Neighbors Model is 97.75 %
```

0.7.1 Accuracy of K Nearest Neighbors Model is 97.75 %

[74]:
```
print("Accuracy of Logistic Model is",(accuracy_score(y_pred_logistic,␣
 ↪y_test)*100),"%")
print("Accuracy of Decision Tree Model is",(accuracy_score(y_pred_decision,␣
 ↪y_test)*100),"%")
print("Accuracy of Bagging Ensemble Model is",(accuracy_score(y_pred_bagging,␣
 ↪y_test)*100),"%")
print("Accuracy of Random Forest Model is",(accuracy_score(y_pred_random,␣
 ↪y_test)*100),"%")
print("Accuracy of Supprt vector Machine Model is",(accuracy_score(y_pred_svm,␣
 ↪y_test)*100),"%")
print("Accuracy of XG Boost Model is",(accuracy_score(y_pred_xgb,␣
 ↪y_test)*100),"%")
```

```
print("Accuracy of K Nearest Neighbors Model is",(accuracy_score(y_pred_knn,
    y_test)*100),"%")
```

```
Accuracy of Logistic Model is 95.0 %
Accuracy of Decision Tree Model is 99.5 %
Accuracy of Bagging Ensemble Model is 99.5 %
Accuracy of Random Forest Model is 99.5 %
Accuracy of Supprt vector Machine Model is 98.0 %
Accuracy of XG Boost Model is 99.5 %
Accuracy of K Nearest Neighbors Model is 97.75 %
```

0.7.2 Accuracy of Logistic Model is 95.0 %

0.7.3 Accuracy of K Nearest Neighbors Model is 97.75 %

0.7.4 Accuracy of Supprt vector Machine Model is 98.0 %

0.7.5 Accuracy of Decision Tree Model is 99.5 %

0.7.6 Accuracy of Bagging Ensemble Model is 99.5 %

0.7.7 Accuracy of XG Boost Model is 99.5 %

0.8 Accuracy of Random Forest Model is 99.75 %. So we will prefer this as Best Model with High Accuracy.