```
# Importing libraries

from __future__ import print_function
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import classification_report
from sklearn import metrics
from sklearn import tree
import warnings
warnings.filterwarnings('ignore')
```

```
df = pd.read_csv('/content/crop_recommendation.csv')
```

```
df.head()
```

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

```
df.tail()
```

	N	P	K	temperature	humidity	ph	rainfall	label
2195	107	34	32	26.774637	66.413269	6.780064	177.774507	coffee
2196	99	15	27	27.417112	56.636362	6.086922	127.924610	coffee
2197	118	33	30	24.131797	67.225123	6.362608	173.322839	coffee
2198	117	32	34	26.272418	52.127394	6.758793	127.175293	coffee
2199	104	18	30	23.603016	60.396475	6.779833	140.937041	coffee

```
df.size
```

```
17600
```

```
df.shape
```

```
    (2200, 8)
```

```
df.columns
```

```
    Index(['N', 'P', 'K', 'temperature', 'humidity', 'ph', 'rainfall', 'label'],
    dtype='object')
```

```
df['label'].unique()
```

```
    array(['rice', 'maize', 'chickpea', 'kidneybeans', 'pigeonpeas',
           'mothbeans', 'mungbean', 'blackgram', 'lentil', 'pomegranate',
           'banana', 'mango', 'grapes', 'watermelon', 'muskmelon', 'apple',
           'orange', 'papaya', 'coconut', 'cotton', 'jute', 'coffee'],
          dtype=object)
```

```
df.dtypes
```

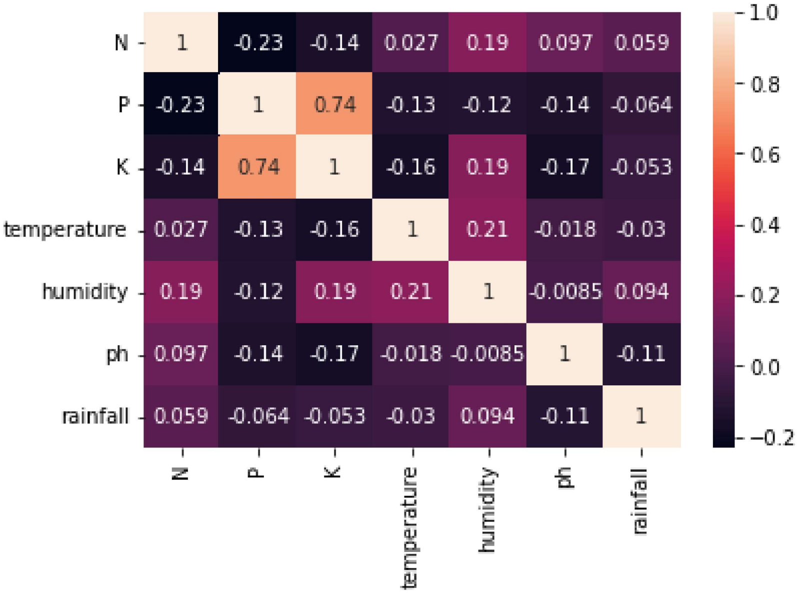
```
    N                  int64
    P                  int64
    K                  int64
    temperature      float64
    humidity         float64
    ph               float64
    rainfall         float64
    label             object
    dtype: object
```

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

```
    rice           100
    maize          100
    jute           100
    cotton         100
    coconut        100
    papaya         100
    orange         100
    apple          100
    muskmelon      100
    watermelon     100
    grapes         100
    mango          100
    banana         100
    pomegranate    100
    lentil         100
    blackgram      100
    mungbean       100
    mothbeans      100
    pigeonpeas     100
    kidneybeans    100
    chickpea       100
    coffee         100
    Name: label, dtype: int64
```

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

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7cab8b7c50>
```



Separating Features and target label

```
features = df[['N', 'P','K','temperature', 'humidity', 'ph', 'rainfall']]
target = df['label']
#features = df[['temperature', 'humidity', 'ph', 'rainfall']]
labels = df['label']
```

```
# Initialzing empty lists to append all model's name and corresponding name
acc = []
model = []
```

```
# Splitting into train and test data

from sklearn.model_selection import train_test_split
Xtrain, Xtest, Ytrain, Ytest = train_test_split(features,target,test_size = 0.2,random_state
```

Decision Tree

```
from sklearn.tree import DecisionTreeClassifier

DecisionTree = DecisionTreeClassifier(criterion="entropy",random_state=2,max_depth=5)

DecisionTree.fit(Xtrain,Ytrain)
```

```
predicted_values = DecisionTree.predict(Xtest)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('Decision Tree')
print("DecisionTrees's Accuracy is: ", x*100)

print(classification_report(Ytest,predicted_values))
```

```
     DecisionTrees's Accuracy is:  90.0
                   precision    recall  f1-score   support

            apple       1.00      1.00      1.00        13
           banana       1.00      1.00      1.00        17
        blackgram       0.59      1.00      0.74        16
         chickpea       1.00      1.00      1.00        21
          coconut       0.91      1.00      0.95        21
           coffee       1.00      1.00      1.00        22
           cotton       1.00      1.00      1.00        20
           grapes       1.00      1.00      1.00        18
             jute       0.74      0.93      0.83        28
      kidneybeans       0.00      0.00      0.00        14
           lentil       0.68      1.00      0.81        23
            maize       1.00      1.00      1.00        21
            mango       1.00      1.00      1.00        26
        mothbeans       0.00      0.00      0.00        19
         mungbean       1.00      1.00      1.00        24
        muskmelon       1.00      1.00      1.00        23
           orange       1.00      1.00      1.00        29
           papaya       1.00      0.84      0.91        19
       pigeonpeas       0.62      1.00      0.77        18
      pomegranate       1.00      1.00      1.00        17
             rice       1.00      0.62      0.77        16
       watermelon       1.00      1.00      1.00        15

         accuracy                           0.90       440
        macro avg       0.84      0.88      0.85       440
     weighted avg       0.86      0.90      0.87       440
```

```
from sklearn.model_selection import cross_val_score
```

```
# Cross validation score (Decision Tree)
score = cross_val_score(DecisionTree, features, target,cv=5)
```

```
score
```

```
     array([0.93636364, 0.90909091, 0.91818182, 0.87045455, 0.93636364])
```

Saving trained Decision Tree Model

```
import pickle
# Dump the trained Naive Bayes classifier with Pickle
DT_pkl_filename = 'DecisionTree.pkl'
# Open the file to save as pkl file
DT_Model_pkl = open(DT_pkl_filename, 'wb')
pickle.dump(DecisionTree, DT_Model_pkl)
# Close the pickle instances
DT_Model_pkl.close()
```

Gaussian Naive Bayes

```
from sklearn.naive_bayes import GaussianNB

NaiveBayes = GaussianNB()

NaiveBayes.fit(Xtrain,Ytrain)

predicted_values = NaiveBayes.predict(Xtest)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('Naive Bayes')
print("Naive Bayes's Accuracy is: ", x)

print(classification_report(Ytest,predicted_values))
```

```
Naive Bayes's Accuracy is:  0.990909090909091
              precision    recall  f1-score   support

       apple       1.00      1.00      1.00        13
      banana       1.00      1.00      1.00        17
   blackgram       1.00      1.00      1.00        16
    chickpea       1.00      1.00      1.00        21
     coconut       1.00      1.00      1.00        21
      coffee       1.00      1.00      1.00        22
      cotton       1.00      1.00      1.00        20
      grapes       1.00      1.00      1.00        18
        jute       0.88      1.00      0.93        28
 kidneybeans       1.00      1.00      1.00        14
      lentil       1.00      1.00      1.00        23
       maize       1.00      1.00      1.00        21
       mango       1.00      1.00      1.00        26
   mothbeans       1.00      1.00      1.00        19
    mungbean       1.00      1.00      1.00        24
   muskmelon       1.00      1.00      1.00        23
      orange       1.00      1.00      1.00        29
      papaya       1.00      1.00      1.00        19
  pigeonpeas       1.00      1.00      1.00        18
 pomegranate       1.00      1.00      1.00        17
        rice       1.00      0.75      0.86        16
  watermelon       1.00      1.00      1.00        15
```

```
    accuracy                           0.99       440
   macro avg       0.99      0.99      0.99       440
weighted avg       0.99      0.99      0.99       440
```

```
# Cross validation score (NaiveBayes)
score = cross_val_score(NaiveBayes,features,target,cv=5)
score
```

```
array([0.99772727, 0.99545455, 0.99545455, 0.99545455, 0.99090909])
```

Saving Trained Gaussian Bayes Model

```
# Dump the trained Naive Bayes classifier with Pickle
NB_pkl_filename = 'NBClassifier.pkl'
# Open the file to save as pkl file
NB_Model_pkl = open(NB_pkl_filename, 'wb')
pickle.dump(NaiveBayes, NB_Model_pkl)
# Close the pickle instances
NB_Model_pkl.close()
```

Support Vector Machine

```
from sklearn.svm import SVC
# data normalization with sklearn
from sklearn.preprocessing import MinMaxScaler
# fit scaler on training data
norm = MinMaxScaler().fit(Xtrain)
X_train_norm = norm.transform(Xtrain)
# transform testing dataabs
X_test_norm = norm.transform(Xtest)
SVM = SVC(kernel='poly', degree=3, C=1)
SVM.fit(X_train_norm,Ytrain)
predicted_values = SVM.predict(X_test_norm)
x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('SVM')
print("SVM's Accuracy is: ", x)

print(classification_report(Ytest,predicted_values))
```

```
SVM's Accuracy is:  0.9795454545454545
              precision    recall  f1-score   support

       apple       1.00      1.00      1.00        13
```

```
      banana       1.00      1.00      1.00        17
   blackgram       1.00      1.00      1.00        16
    chickpea       1.00      1.00      1.00        21
     coconut       1.00      1.00      1.00        21
      coffee       1.00      0.95      0.98        22
      cotton       0.95      1.00      0.98        20
      grapes       1.00      1.00      1.00        18
        jute       0.83      0.89      0.86        28
 kidneybeans       1.00      1.00      1.00        14
      lentil       1.00      1.00      1.00        23
       maize       1.00      0.95      0.98        21
       mango       1.00      1.00      1.00        26
   mothbeans       1.00      1.00      1.00        19
    mungbean       1.00      1.00      1.00        24
   muskmelon       1.00      1.00      1.00        23
      orange       1.00      1.00      1.00        29
      papaya       1.00      1.00      1.00        19
  pigeonpeas       1.00      1.00      1.00        18
 pomegranate       1.00      1.00      1.00        17
        rice       0.80      0.75      0.77        16
  watermelon       1.00      1.00      1.00        15

    accuracy                           0.98       440
   macro avg       0.98      0.98      0.98       440
weighted avg       0.98      0.98      0.98       440
```

```
# Cross validation score (SVM)
score = cross_val_score(SVM,features,target,cv=5)
score
```

```
array([0.97954545, 0.975     , 0.98863636, 0.98863636, 0.98181818])
```

Saving Trained SVM Model

```
# Dump the trained SVM classifier with Pickle
SVM_pkl_filename = 'SVMClassifier.pkl'
# Open the file to save as pkl file
SVM_Model_pkl = open(SVM_pkl_filename, 'wb')
pickle.dump(SVM, SVM_Model_pkl)
# Close the pickle instances
SVM_Model_pkl.close()
```

Logistic Regression

```
from sklearn.linear_model import LogisticRegression
```

```
LogReg = LogisticRegression(random_state=2)

LogReg.fit(Xtrain,Ytrain)

predicted_values = LogReg.predict(Xtest)

x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('Logistic Regression')
print("Logistic Regression's Accuracy is: ", x)

print(classification_report(Ytest,predicted_values))
```

```
Logistic Regression's Accuracy is:  0.9522727272727273
              precision    recall  f1-score   support

       apple       1.00      1.00      1.00        13
      banana       1.00      1.00      1.00        17
   blackgram       0.86      0.75      0.80        16
    chickpea       1.00      1.00      1.00        21
     coconut       1.00      1.00      1.00        21
      coffee       1.00      1.00      1.00        22
      cotton       0.86      0.90      0.88        20
      grapes       1.00      1.00      1.00        18
        jute       0.84      0.93      0.88        28
 kidneybeans       1.00      1.00      1.00        14
      lentil       0.88      1.00      0.94        23
       maize       0.90      0.86      0.88        21
       mango       0.96      1.00      0.98        26
   mothbeans       0.84      0.84      0.84        19
    mungbean       1.00      0.96      0.98        24
   muskmelon       1.00      1.00      1.00        23
      orange       1.00      1.00      1.00        29
      papaya       1.00      0.95      0.97        19
  pigeonpeas       1.00      1.00      1.00        18
 pomegranate       1.00      1.00      1.00        17
        rice       0.85      0.69      0.76        16
  watermelon       1.00      1.00      1.00        15

    accuracy                           0.95       440
   macro avg       0.95      0.95      0.95       440
weighted avg       0.95      0.95      0.95       440
```

```
# Cross validation score (Logistic Regression)
score = cross_val_score(LogReg,features,target,cv=5)
score
```

```
array([0.95      , 0.96590909, 0.94772727, 0.96818182, 0.94318182])
```

Saving Trained Logistic Regression Model

```
# Dump the trained Naive Bayes classifier with Pickle
LR_pkl_filename = 'Logistic_Regression.pkl'
# Open the file to save as pkl file
LR_Model_pkl = open(DT_pkl_filename, 'wb')
pickle.dump(LogReg, LR_Model_pkl)
# Close the pickle instances
LR_Model_pkl.close()
```

Random Forest

```
from sklearn.ensemble import RandomForestClassifier

RF = RandomForestClassifier(n_estimators=20, random_state=0)
RF.fit(Xtrain,Ytrain)

predicted_values = RF.predict(Xtest)

x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('RF')
print("RF's Accuracy is: ", x)

print(classification_report(Ytest,predicted_values))
```

```
RF's Accuracy is:  0.990909090909091
              precision    recall  f1-score   support

       apple       1.00      1.00      1.00        13
      banana       1.00      1.00      1.00        17
   blackgram       0.94      1.00      0.97        16
    chickpea       1.00      1.00      1.00        21
     coconut       1.00      1.00      1.00        21
      coffee       1.00      1.00      1.00        22
      cotton       1.00      1.00      1.00        20
      grapes       1.00      1.00      1.00        18
        jute       0.90      1.00      0.95        28
 kidneybeans       1.00      1.00      1.00        14
      lentil       1.00      1.00      1.00        23
       maize       1.00      1.00      1.00        21
       mango       1.00      1.00      1.00        26
   mothbeans       1.00      0.95      0.97        19
    mungbean       1.00      1.00      1.00        24
   muskmelon       1.00      1.00      1.00        23
      orange       1.00      1.00      1.00        29
      papaya       1.00      1.00      1.00        19
  pigeonpeas       1.00      1.00      1.00        18
 pomegranate       1.00      1.00      1.00        17
        rice       1.00      0.81      0.90        16
  watermelon       1.00      1.00      1.00        15
```

```
        accuracy                           0.99       440
       macro avg       0.99      0.99      0.99       440
    weighted avg       0.99      0.99      0.99       440
```

```
# Cross validation score (Random Forest)
score = cross_val_score(RF,features,target,cv=5)
score
```

```
    array([0.99772727, 0.99545455, 0.99772727, 0.99318182, 0.98863636])
```

Saving Trained Random Forest Model

```
# Dump the trained Naive Bayes classifier with Pickle
RF_pkl_filename = 'RandomForest.pkl'
# Open the file to save as pkl file
RF_Model_pkl = open(RF_pkl_filename, 'wb')
pickle.dump(RF, RF_Model_pkl)
# Close the pickle instances
RF_Model_pkl.close()
```

XG Boost

```
import xgboost as xgb
XB = xgb.XGBClassifier()
XB.fit(Xtrain,Ytrain)

predicted_values = XB.predict(Xtest)

x = metrics.accuracy_score(Ytest, predicted_values)
acc.append(x)
model.append('XGBoost')
print("XGBoost's Accuracy is: ", x)

print(classification_report(Ytest,predicted_values))
```

```
    XGBoost's Accuracy is:  0.9931818181818182
                  precision    recall  f1-score   support

           apple       1.00      1.00      1.00        13
          banana       1.00      1.00      1.00        17
       blackgram       1.00      1.00      1.00        16
        chickpea       1.00      1.00      1.00        21
         coconut       1.00      1.00      1.00        21
          coffee       1.00      1.00      1.00        22
```

```
           cotton       1.00      1.00      1.00        20
           grapes       1.00      1.00      1.00        18
             jute       0.96      0.93      0.95        28
      kidneybeans       1.00      1.00      1.00        14
           lentil       1.00      1.00      1.00        23
            maize       1.00      1.00      1.00        21
            mango       1.00      1.00      1.00        26
        mothbeans       1.00      1.00      1.00        19
         mungbean       1.00      1.00      1.00        24
        muskmelon       1.00      1.00      1.00        23
           orange       1.00      1.00      1.00        29
           papaya       1.00      1.00      1.00        19
       pigeonpeas       1.00      1.00      1.00        18
      pomegranate       1.00      1.00      1.00        17
             rice       0.88      0.94      0.91        16
       watermelon       1.00      1.00      1.00        15

         accuracy                           0.99       440
        macro avg       0.99      0.99      0.99       440
     weighted avg       0.99      0.99      0.99       440
```

```
# Cross validation score (XGBoost)
score = cross_val_score(XB,features,target,cv=5)
score
```

```
     array([0.98636364, 0.99318182, 0.99545455, 0.99090909, 0.98409091])
```

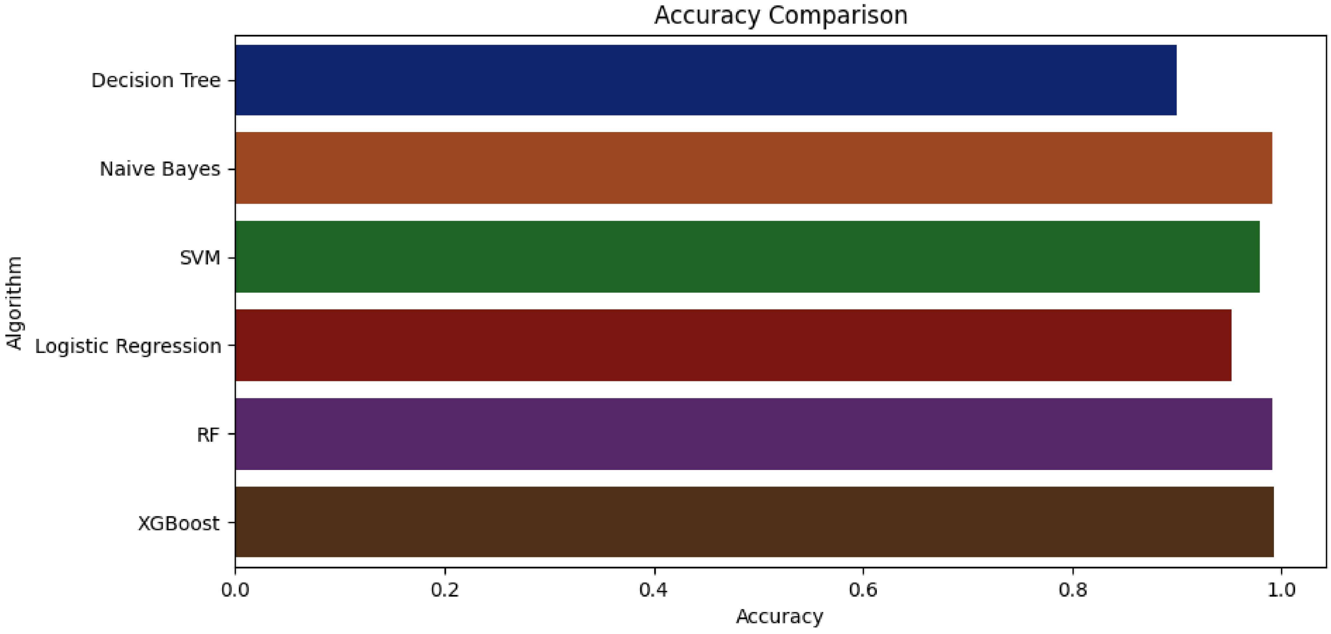
Saving Trained XG Boost Model

```
# Dump the trained Naive Bayes classifier with Pickle
XB_pkl_filename = 'XGBoost.pkl'
# Open the file to save as pkl file
XB_Model_pkl = open(XB_pkl_filename, 'wb')
pickle.dump(XB, XB_Model_pkl)
# Close the pickle instances
XB_Model_pkl.close()
```

Accuarcy Comparision

```
plt.figure(figsize=[10,5],dpi = 100)
plt.title('Accuracy Comparison')
plt.xlabel('Accuracy')
plt.ylabel('Algorithm')
sns.barplot(x = acc,y = model,palette='dark')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7ca8685550>
```



```
accuracy_models = dict(zip(model, acc))
for k, v in accuracy_models.items():
    print (k, '-->', v)
```

```
Decision Tree --> 0.9
Naive Bayes --> 0.990909090909091
SVM --> 0.9795454545454545
Logistic Regression --> 0.9522727272727273
RF --> 0.990909090909091
XGBoost --> 0.9931818181818182
```

Making a Prediction

```
data = np.array([[104,18, 30, 23.603016, 60.3, 6.7, 140.91]])
prediction = RF.predict(data)
print(prediction)
```

```
['coffee']
```

```
data = np.array([[83, 45, 60, 28, 70.3, 7.0, 150.9]])
prediction = RF.predict(data)
print(prediction)
```

```
['jute']
```