## Importing libraries

```
from __future__ import print_function
import pickle
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
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import cross_val_score
warnings.filterwarnings('ignore')
```

## Reading Data

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

## Exploratory Data

```
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 |

```
1 df.size
```

```
17600
```

```
1 df.shape
```

```
(2200, 8)
```

```
1 df.columns
```

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

```
1 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)
```

```
1 df.dtypes
```

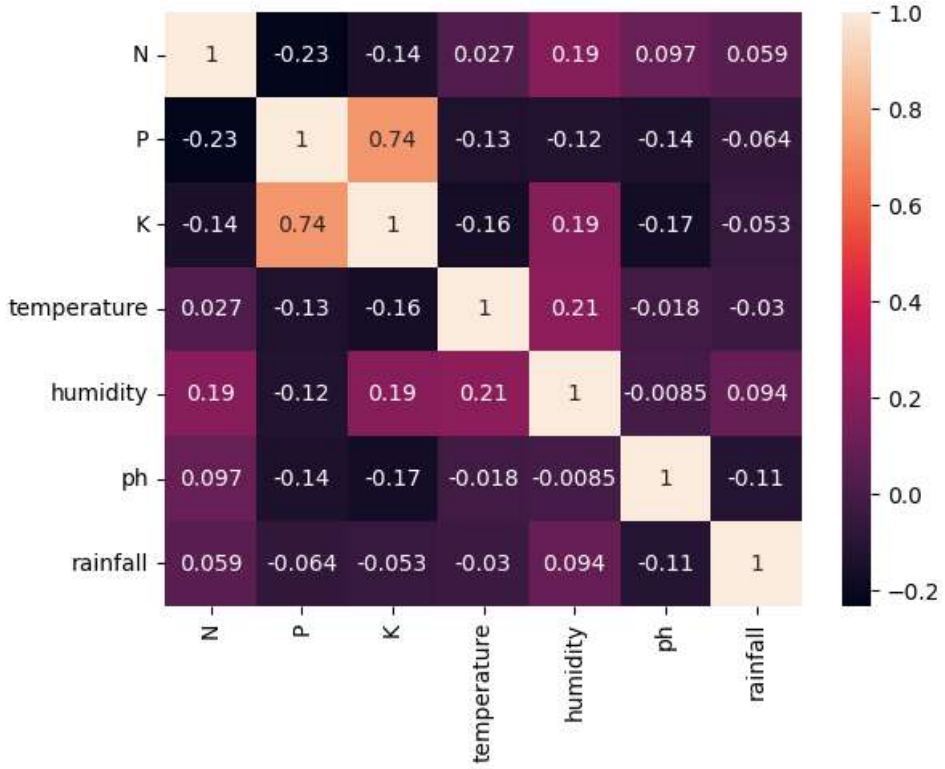
```
N               int64
P               int64
K               int64
temperature   float64
humidity      float64
ph            float64
rainfall      float64
label          object
dtype: object
```

```
1 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
```

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

```
<Axes: >
```




## Seperating features and target label

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

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

## Splitting into train and test data

```
Xtrain, Xtest, Ytrain, Ytest = train_test_split(features,target,test_size = 0.2,random_state =2)
```

# Classification Algorithms:

## Decision Tree

```
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
```

```
# 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

```
# 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()
```

# Guassian Naive Bayes

```
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 Guassian Naive 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 (SVM)

```
SVM = SVC(gamma='auto')

SVM.fit(Xtrain,Ytrain)

predicted_values = SVM.predict(Xtest)

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:  0.10681818181818181
              precision    recall  f1-score   support

       apple       1.00      0.23      0.38        13
      banana       1.00      0.24      0.38        17
   blackgram       1.00      0.19      0.32        16
    chickpea       1.00      0.05      0.09        21
     coconut       1.00      0.05      0.09        21
      coffee       0.00      0.00      0.00        22
      cotton       1.00      0.05      0.10        20
      grapes       1.00      0.06      0.11        18
        jute       1.00      0.07      0.13        28
 kidneybeans       0.03      1.00      0.07        14
      lentil       0.00      0.00      0.00        23
       maize       0.00      0.00      0.00        21
       mango       0.00      0.00      0.00        26
   mothbeans       0.00      0.00      0.00        19
    mungbean       1.00      0.12      0.22        24
   muskmelon       1.00      0.30      0.47        23
      orange       1.00      0.03      0.07        29
      papaya       1.00      0.05      0.10        19
  pigeonpeas       0.00      0.00      0.00        18
 pomegranate       1.00      0.12      0.21        17
        rice       0.50      0.06      0.11        16
  watermelon       1.00      0.13      0.24        15

    accuracy                           0.11       440
   macro avg       0.66      0.13      0.14       440
weighted avg       0.66      0.11      0.13       440
```

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

```
array([0.27727273, 0.28863636, 0.29090909, 0.275     , 0.26818182])
```

## Logistic Regression

```
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, 0.96590909, 0.94318182])
```

## Saving trained Logistic Regression model

```
# Dump the trained Naive Bayes classifier with Pickle
LR_pkl_filename = 'LogisticRegression.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

```

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

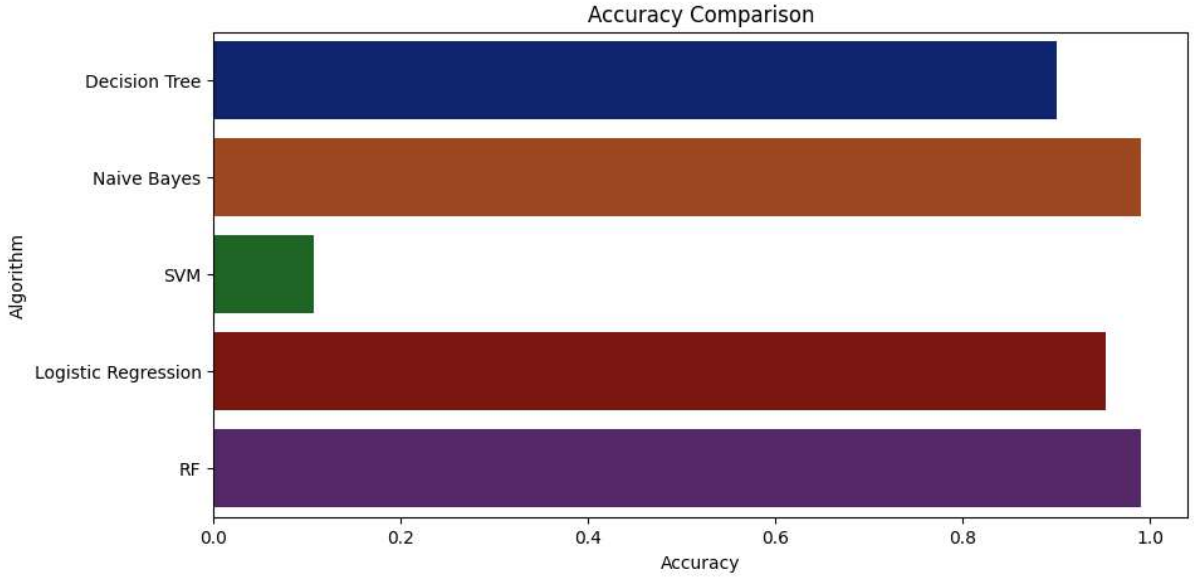
```

# 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()
```

## Accuracy Comparison

```
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')
```

```
<Axes: title={'center': 'Accuracy Comparison'}, xlabel='Accuracy', ylabel='Algorithm'>
```




```
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 --> 0.10681818181818181
Logistic Regression --> 0.9522727272727273
RF --> 0.990909090909091
```

## Making a prediction

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

```
['jute']
```

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

```
['jute']
```

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

```
['kidneybeans']
```

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