Internship Major Project

Topic : **Crop Recommendation**

Problem Statement : Predict the type of crop based on various factors such as temperature, humidity, rainfall, soil pH and other nutrients.

Data fields

- N - ratio of Nitrogen content in soil
- P - ratio of Phosphorous content in soil
- K - ratio of Potassium content in soil
- temperature - temperature in degree Celsius
- humidity - relative humidity in %
- ph - ph value of the soil
- rainfall - rainfall in mm

This problem is classification problem as dataset is labelled (i.e. supervised learning). We have predicted result using five classification algorithms.

- Logistic regression
- Decision tree
- Random forest
- Support vector machine
- K-nearest Neighbor

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

1) Acquiring the Data

```
df = pd.read_csv('Crop_recommendation.csv')
df
```

	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
...	...	...	...	...	...	...	...	...
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

2200 rows × 8 columns

```
df.shape
```

```
(2200, 8)
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2200 entries, 0 to 2199
Data columns (total 8 columns):
```

```
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   N            2200 non-null   int64
 1   P            2200 non-null   int64
 2   K            2200 non-null   int64
 3   temperature  2200 non-null   float64
 4   humidity     2200 non-null   float64
 5   ph           2200 non-null   float64
 6   rainfall     2200 non-null   float64
 7   label        2200 non-null   object
dtypes: float64(4), int64(3), object(1)
memory usage: 137.6+ KB
```

```
df.describe()
```

	N	P	K	temperature	humidity	ph	rainfall
count	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000
mean	50.551818	53.362727	48.149091	25.616244	71.481779	6.469480	103.463655
std	36.917334	32.985883	50.647931	5.063749	22.263812	0.773938	54.958389
min	0.000000	5.000000	5.000000	8.825675	14.258040	3.504752	20.211267
25%	21.000000	28.000000	20.000000	22.769375	60.261953	5.971693	64.551686
50%	37.000000	51.000000	32.000000	25.598693	80.473146	6.425045	94.867624
75%	84.250000	68.000000	49.000000	28.561654	89.948771	6.923643	124.267508
max	140.000000	145.000000	205.000000	43.675493	99.981876	9.935091	298.560117

2) Preprocess the Data

```
df.isna().sum()
```

```
N              0
P              0
K              0
temperature    0
humidity       0
ph             0
rainfall       0
label          0
dtype: int64
```

```
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
```

```
X = df.drop('label', axis=1)
y = df['label']
```

```
X
```

	N	P	K	temperature	humidity	ph	rainfall
0	90	42	43	20.879744	82.002744	6.502985	202.935536
1	85	58	41	21.770462	80.319644	7.038096	226.655537
2	60	55	44	23.004459	82.320763	7.840207	263.964248
3	74	35	40	26.491096	80.158363	6.980401	242.864034
4	78	42	42	20.130175	81.604873	7.628473	262.717340
...	...	...	...	...	...	...	...
2195	107	34	32	26.774637	66.413269	6.780064	177.774507
2196	99	15	27	27.417112	56.636362	6.086922	127.924610
2197	118	33	30	24.131797	67.225123	6.362608	173.322839
2198	117	32	34	26.272418	52.127394	6.758793	127.175293
2199	104	18	30	23.603016	60.396475	6.779833	140.937041

```
y
```

```
0         rice
1         rice
2         rice
3         rice
4         rice
         ...
2195    coffee
2196    coffee
2197    coffee
2198    coffee
2199    coffee
Name: label, Length: 2200, dtype: object
```

3) Train-Test Split

```
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=48)
```

```
print(X_train.shape)
print(X_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(1760, 7)
(440, 7)
(1760,)
(440,)
```

```
X_train
```

	N	P	K	temperature	humidity	ph	rainfall
1064	92	85	51	29.221186	81.081836	5.740765	108.861647
485	18	55	23	21.998983	56.310068	6.985720	136.827431
1802	13	28	33	28.130115	95.648076	5.686973	151.076190
131	63	43	19	18.518168	55.531281	6.641906	90.988051
694	4	40	21	28.797281	80.457444	6.725551	44.300705
...	...	...	...	...	...	...	...
454	5	56	24	24.807102	45.011100	5.023115	188.492864
966	3	27	44	24.568112	92.030092	6.591303	110.963389
1856	10	24	27	27.572835	94.904857	5.708410	145.929893
1476	80	18	52	27.873174	91.148496	6.484800	24.052079
1361	101	17	55	24.371182	87.126913	6.451500	44.639077

1760 rows × 7 columns

```
X_test
```

	N	P	K	temperature	humidity	ph	rainfall
10	91	53	40	26.527235	81.417538	5.386168	264.614870
1132	12	31	26	35.787774	51.941903	5.395276	100.216061
97	60	55	45	21.408658	83.329319	5.935745	287.576693
1813	37	18	30	27.635513	99.348549	6.384884	157.917154
345	17	77	24	20.769522	18.931469	5.568457	109.019371
...	...	...	...	...	...	...	...
156	84	44	21	21.869274	61.910449	5.850440	107.268193
1170	18	20	26	31.665247	51.985946	5.435841	89.980243
1827	11	6	25	28.691648	96.652487	6.081568	178.963546
1459	95	16	46	27.076726	90.143626	6.746695	24.451465
1617	22	17	5	24.121887	90.723516	6.945563	102.835632

440 rows × 7 columns

4) Train the Model

```
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
```

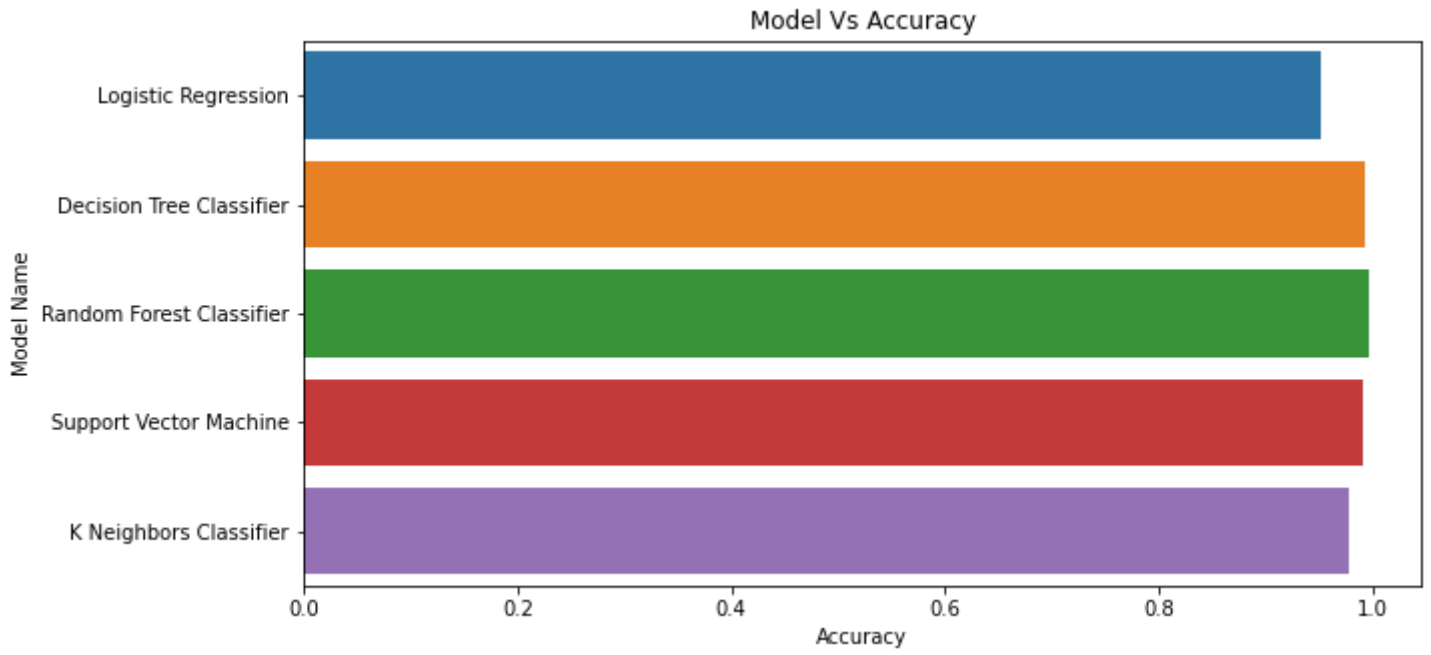
```
models = []
models.append(('Logistic Regression', LogisticRegression(random_state=1)))
models.append(('Decision Tree Classifier', DecisionTreeClassifier(random_state=1)))
models.append(('Random Forest Classifier', RandomForestClassifier(n_estimators=75,criterion='entropy',random_state=1
models.append(('Support Vector Machine', SVC(kernel='rbf',random_state=1)))
models.append(('K Neighbors Classifier', KNeighborsClassifier(n_neighbors=5)))
```

```
model_name = []
accuracies = []

for name,model in models:
  result = model.fit(X_train,y_train)
  predictions = result.predict(X_test)
  accuracy = accuracy_score(y_test, predictions)
  model_name.append(name)
  accuracies.append(accuracy)


for i in range(len(model_name)):
  print(model_name[i]," : ",accuracies[i])
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:818: ConvergenceWarning: lbfgs failed to converge (sta
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  extra_warning_msg=_LOGISTIC_SOLVER_CONVERGENCE_MSG,
Logistic Regression  :  0.9522727272727273
Decision Tree Classifier  :  0.9931818181818182
Random Forest Classifier  :  0.9954545454545455
Support Vector Machine  :  0.990909090909091
K Neighbors Classifier  :  0.9772727272727273
```

```
plt.figure(figsize=(10,5))
plt.title("Model Vs Accuracy")
plt.xlabel("Accuracy")
plt.ylabel("Model Name")
sns.barplot(y=model_name, x=accuracies, saturation=0.8)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f2cda13db90>
```



From the above graph, we have come to a conclusion that Random Forest Classifier and Decision Tree Classifier has the best accuracy among all. So we proceeded with Random Forest Classifier as a best-suited model for our given problem statement.

```
my_model = RandomForestClassifier(n_estimators=75,criterion='entropy',random_state=1)
result = my_model.fit(X_train,y_train)
```

5) Test the Model

```
predictions = result.predict(X_test)
predictions[:100]
```

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

```
accuracy_score(y_test, predictions)
```

```
0.9954545454545455
```

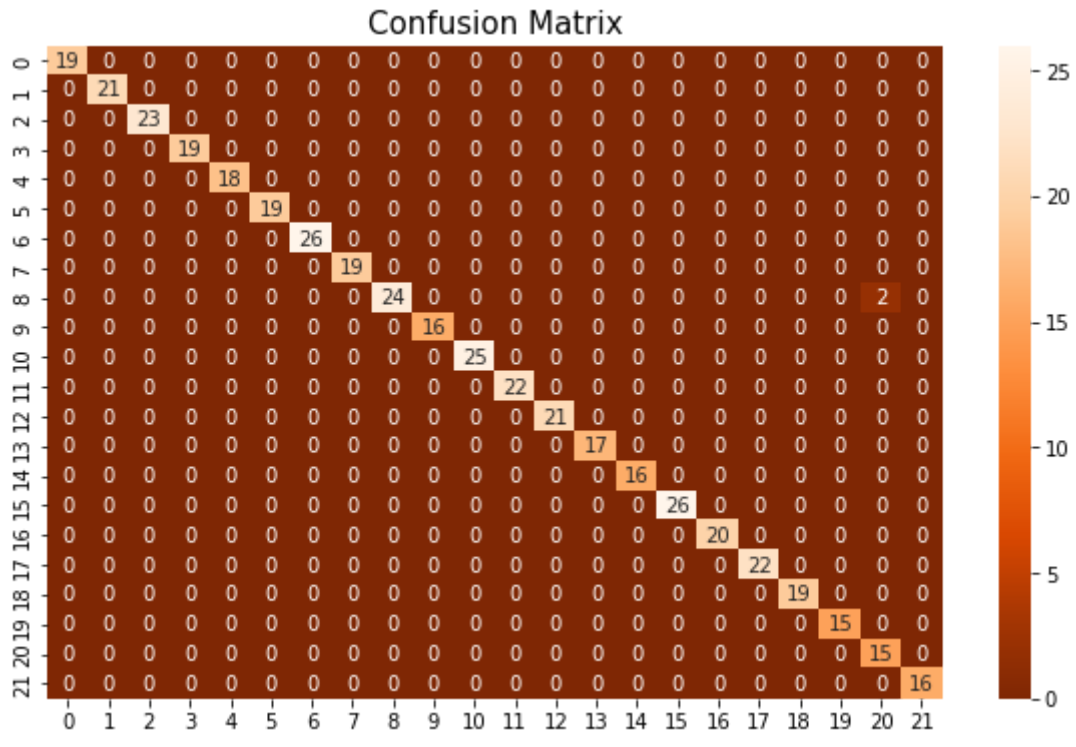
```
from sklearn.metrics import classification_report
print("Classification report :\n",classification_report(y_test, predictions))
```

```
Classification report :
               precision    recall  f1-score   support

       apple       1.00      1.00      1.00        19
      banana       1.00      1.00      1.00        21
   blackgram       1.00      1.00      1.00        23
    chickpea       1.00      1.00      1.00        19
     coconut       1.00      1.00      1.00        18
      coffee       1.00      1.00      1.00        19
      cotton       1.00      1.00      1.00        26
      grapes       1.00      1.00      1.00        19
        jute       1.00      0.92      0.96        26
 kidneybeans       1.00      1.00      1.00        16
      lentil       1.00      1.00      1.00        25
       maize       1.00      1.00      1.00        22
       mango       1.00      1.00      1.00        21
   mothbeans       1.00      1.00      1.00        17
    mungbean       1.00      1.00      1.00        16
   muskmelon       1.00      1.00      1.00        26
```

orange	1.00	1.00	1.00	20
papaya	1.00	1.00	1.00	22
pigeonpeas	1.00	1.00	1.00	19
pomegranate	1.00	1.00	1.00	15
rice	0.88	1.00	0.94	15
watermelon	1.00	1.00	1.00	16
accuracy			1.00	440
macro avg	0.99	1.00	1.00	440
weighted avg	1.00	1.00	1.00	440

```
from sklearn.metrics import confusion_matrix
confusion_mat = confusion_matrix(y_test, predictions)
```

```
plt.figure(figsize=(10,6))
sns.heatmap(confusion_mat, annot=True, fmt="1.0f", cmap="Oranges_r")
plt.title("Confusion Matrix", size = 15);
```



6) Deploy the Model

```
new_pred = result.predict([[90,42,43,20.87974371,82.00274423,6.502985292,202.9355362]])  #1st line
new_pred
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:451: UserWarning: X does not have valid feature names, but RandomForestC
  "X does not have valid feature names, but"
array(['rice'], dtype=object)
```

```
new_pred2 = result.predict([[37,73,21,29.50304807,63.46513414,5.560224583,189.5208915]])   #475 line
new_pred2
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:451: UserWarning: X does not have valid feature names, but RandomForestC
  "X does not have valid feature names, but"
array(['pigeonpeas'], dtype=object)
```

```
new_pred3 = result.predict([[12,31,26,35.7877738,51.94190321,5.395275719,100.2160615]])   #1134 line
new_pred3
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:451: UserWarning: X does not have valid feature names, but RandomForestC
  "X does not have valid feature names, but"
array(['mango'], dtype=object)
```

```
new_pred4 = result.predict([[115,48,16,25.54359718,84.09229796,7.175934962,88.94245493]])   #1134 line
new_pred4
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/base.py:451: UserWarning: X does not have valid feature names, but RandomForestC
  "X does not have valid feature names, but"
array(['cotton'], dtype=object)
```