Intelligent Crop Recommendation System

```
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
import warnings
warnings.filterwarnings('ignore')
```

```
data = pd.read_csv('/content/drive/MyDrive/Colab Notebooks_ML/Project/Crop_recommendation_.csv')
data.head()
```

	N	P	K	temperature	humidity	ph	rainfall	label
0	90.0	42.0	43.0	20.879744	82.002744	6.502985	202.935536	rice
1	85.0	58.0	41.0	21.770462	80.319644	7.038096	226.655537	rice
2	83.0	40.0	44.0	21.525540	80.212360	5.956130	NaN	rice
3	60.0	55.0	44.0	23.004459	82.320763	7.840207	263.964248	rice
4	74.0	35.0	40.0	26.491096	80.158363	6.980401	242.864034	rice

```
data.tail()
```

	N	P	K	temperature	humidity	ph	rainfall	label
2215	107.0	34.0	32.0	26.774637	66.413269	6.780064	177.774507	coffee
2216	99.0	15.0	27.0	27.417112	56.636362	6.086922	127.924610	coffee
2217	118.0	33.0	30.0	24.131797	67.225123	6.362608	173.322839	coffee
2218	117.0	32.0	34.0	26.272418	52.127394	6.758793	127.175293	coffee
2219	104.0	18.0	30.0	23.603016	60.396475	6.779833	140.937041	coffee

```
data.shape
```

```
(2220, 8)
```

```
data.size
```

```
17760
```

```
data.dtypes
```

```
N              float64
P              float64
K              float64
temperature    float64
humidity       float64
ph             float64
```

```
rainfall       float64
label           object
dtype: object
```

```
data.rename(columns={"N":"Nitrogen","P":"Phosphorous","K":"Potassium","label":"Crop"},inplace=True)
data.head()
```

	Nitrogen	Phosphorous	Potassium	temperature	humidity	ph	rainfall	Crop
0	90.0	42.0	43.0	20.879744	82.002744	6.502985	202.935536	rice
1	85.0	58.0	41.0	21.770462	80.319644	7.038096	226.655537	rice
2	83.0	40.0	44.0	21.525540	80.212360	5.956130	NaN	rice
3	60.0	55.0	44.0	23.004459	82.320763	7.840207	263.964248	rice
4	74.0	35.0	40.0	26.491096	80.158363	6.980401	242.864034	rice

```
data.describe()
```

	Nitrogen	Phosphorous	Potassium	temperature	humidity	ph	rainfall
count	2216.000000	2215.000000	2219.000000	2217.000000	2218.000000	2218.000000	2217.000000
mean	50.488267	53.296163	48.092384	25.607468	71.452329	6.470305	103.306011
std	36.869116	32.925813	50.581381	5.078371	22.286509	0.772505	54.955422
min	0.000000	5.000000	5.000000	8.825675	14.258040	3.504752	20.211267
25%	21.000000	28.000000	20.000000	22.750888	60.270822	5.971933	64.328871
50%	37.000000	51.000000	32.000000	25.567483	80.464995	6.426829	94.761894
75%	84.000000	68.000000	49.000000	28.562122	89.936402	6.924379	123.649515
max	140.000000	145.000000	205.000000	43.675493	99.981876	9.935091	298.560117

```
data['Crop'].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)
```

```
data['Crop'].nunique()
```

```
22
```

```
data['Crop'].value_counts()
```

```
pomegranate    102
kidneybeans    102
rice           102
mungbean       102
lentil         102
maize          102
muskmelon      102
```

```
grapes         101
pigeonpeas     101
blackgram      101
chickpea       101
orange         101
papaya         101
jute           100
watermelon     100
coconut        100
mothbeans      100
mango          100
coffee         100
cotton         100
apple          100
banana         100
Name: Crop, dtype: int64
```

```
data.isnull().sum()
```

```
Nitrogen       4
Phosphorous    5
Potassium      1
temperature    3
humidity       2
ph             2
rainfall       3
Crop           0
dtype: int64
```

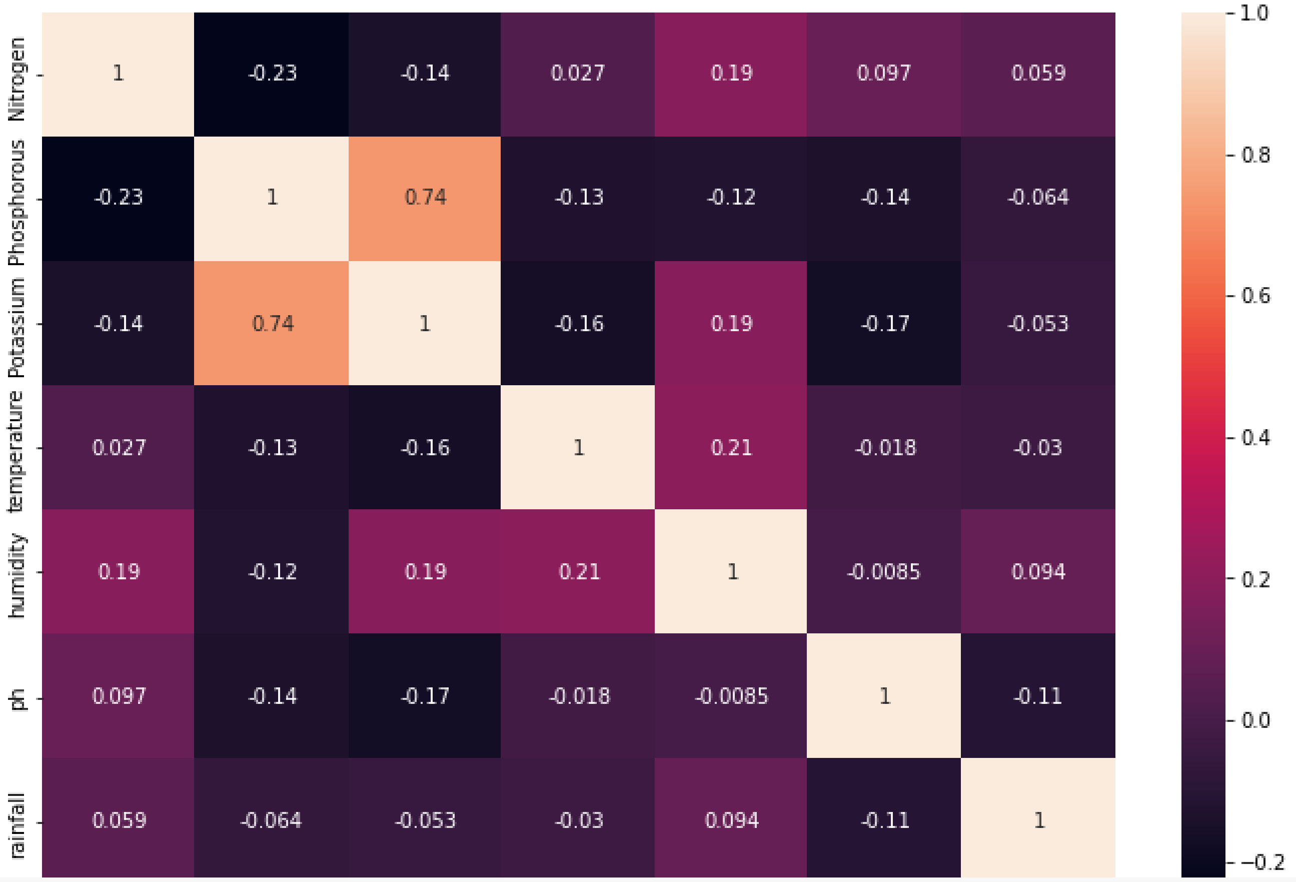
```
data.dropna(inplace=True)
data.head()
```

	Nitrogen	Phosphorous	Potassium	temperature	humidity	ph	rainfall	Crop
0	90.0	42.0	43.0	20.879744	82.002744	6.502985	202.935536	rice
1	85.0	58.0	41.0	21.770462	80.319644	7.038096	226.655537	rice
3	60.0	55.0	44.0	23.004459	82.320763	7.840207	263.964248	rice
4	74.0	35.0	40.0	26.491096	80.158363	6.980401	242.864034	rice
5	78.0	42.0	42.0	20.130175	81.604873	7.628473	262.717340	rice

```
data.isnull().sum()
```

```
Nitrogen       0
Phosphorous    0
Potassium      0
temperature    0
humidity       0
ph             0
rainfall       0
Crop           0
dtype: int64
```

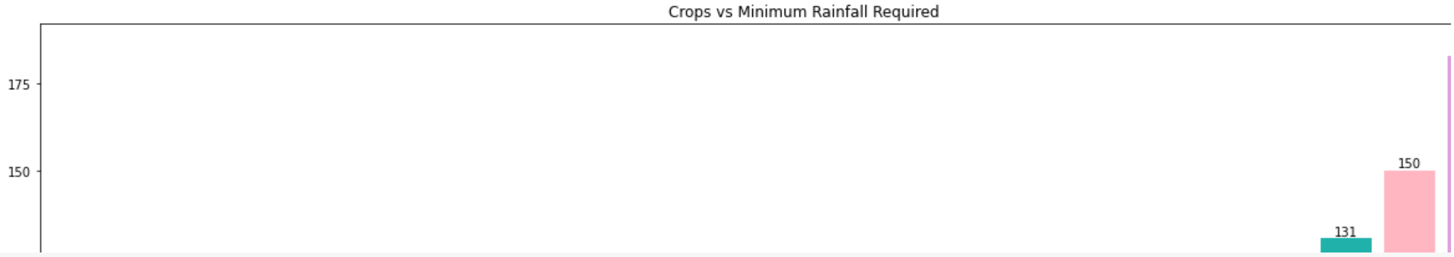
```
plt.figure(figsize=(12,8))
sns.heatmap(data.corr(),annot=True);
```



```
colors=['tomato', 'gold', 'forestgreen', 'royalblue', 'cyan', 'orange', 'pink', 'brown', 'purple', '
        'teal', 'lightcoral', 'gray', 'khaki', 'violet', 'springgreen', 'indianred', 'lavender', 'ye
        'lightseagreen', 'lightpink', 'plum']
```

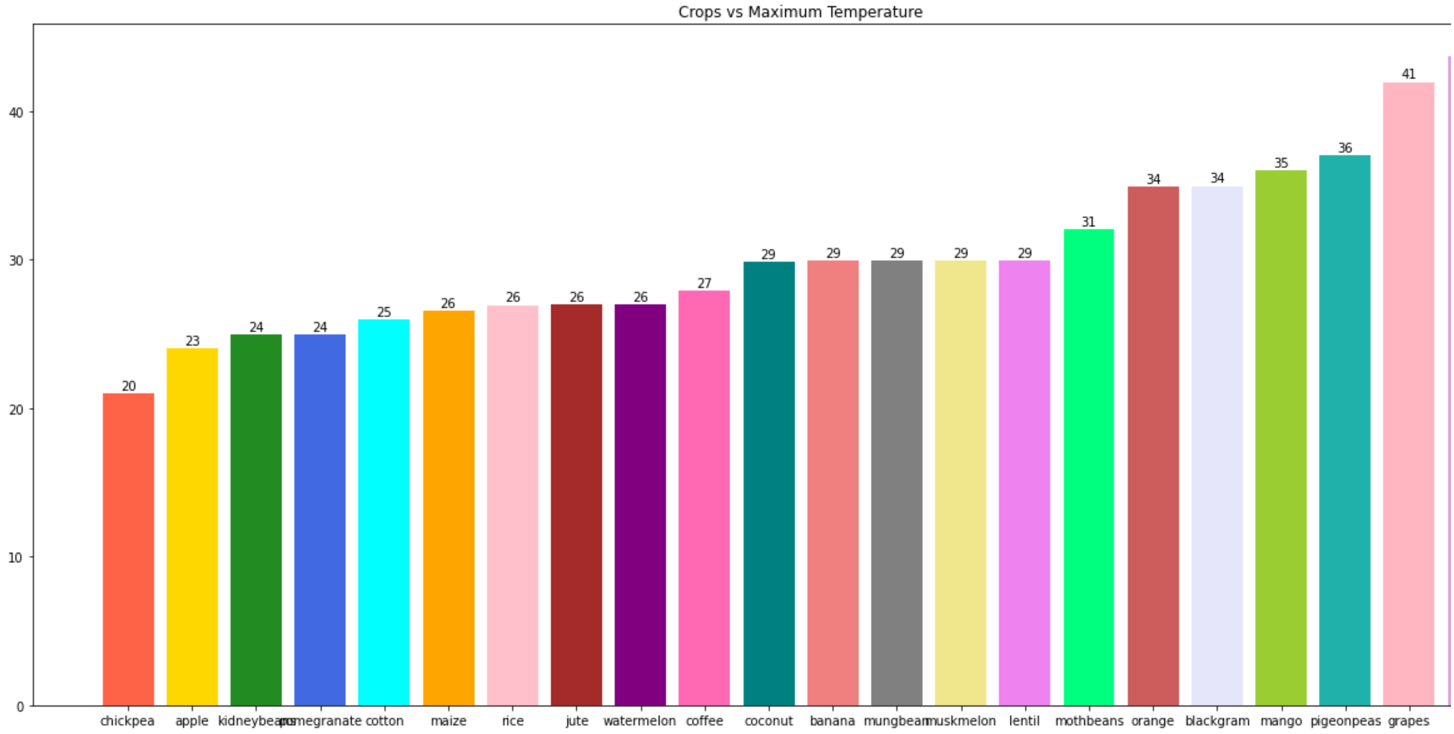
```
crop = data.groupby(by='Crop')['rainfall'].min().reset_index().sort_values(by='rainfall')
crop
fig, ax = plt.subplots(figsize=(22,10))
plt.tick_params(labelsize=10)
plt.bar(crop.Crop, crop.rainfall, color=colors)
for x,y in zip(crop.Crop, crop.rainfall):
    plt.text(x, y+0.1, '%d' % y, ha='center', va='bottom')
plt.title('Crops vs Minimum Rainfall Required')
```

```
Text(0.5, 1.0, 'Crops vs Minimum Rainfall Required')
```



```
crop = data.groupby(by='Crop')['temperature'].max().reset_index().sort_values(by='temperature')
crop
fig, ax = plt.subplots(figsize=(22,10))
plt.tick_params(labelsize=10)
plt.bar(crop.Crop, crop.temperature, color=colors)
for x,y in zip(crop.Crop, crop.temperature):
    plt.text(x, y+0.1, '%d' % y, ha='center', va= 'bottom')
plt.title('Crops vs Maximum Temperature')
```

```
Text(0.5, 1.0, 'Crops vs Maximum Temperature')
```



Checking outliers based on specific Crop using IQR

```
cotton_data = data.loc[data['Crop']=='cotton']
cotton_data.head()
```

	Nitrogen	Phosphorous	Potassium	temperature	humidity	ph	rainfall	Crop
1920	133.0	47.0	24.0	24.402289	79.197320	7.231325	90.802236	cotton
1921	136.0	36.0	20.0	23.095956	84.862757	6.925412	71.295811	cotton

```
cotton_data.shape
```

```
(100, 8)
```

1924	126.0	38.0	23.0	25.362438	83.632761	6.176716	88.436189	cotton

```
q1=np.percentile(cotton_data['temperature'],25)
q1
```

```
23.01761537
```

```
q3=np.percentile(cotton_data['temperature'],75)
q3
```

```
24.97373546
```

```
iqr=q3-q1
iqr
```

```
1.9561200899999989
```

```
cut_off = 1.5*iqr
cut_off
```

```
2.9341801349999983
```

```
lower, upper = q1 - cut_off, q3 + cut_off
print(lower)
print(upper)
```

```
20.083435235000003
27.907915595
```

```
outliers = [x for x in cotton_data['temperature'] if (x<lower) or (x>upper)]
outliers
```

```
[]
```

Checking outliers based on specific Crop using Standard Deviation

```
cotton_data = data.loc[data['Crop']=='cotton']
cotton_data.head()
```

	Nitrogen	Phosphorous	Potassium	temperature	humidity	ph	rainfall	Crop
1920	133.0	47.0	24.0	24.402289	79.197320	7.231325	90.802236	cotton

```
cotton_data.shape
```

```
(100, 8)
```

```
mean = cotton_data['temperature'].mean()
mean
```

```
23.988957895200016
```

```
std = cotton_data['temperature'].std()
std
```

```
1.135681479912332
```

```
cut_off = std*3
cut_off
```

```
3.407044439736996
```

```
lower, upper = mean - cut_off, mean + cut_off
print(lower)
print(upper)
```

```
20.58191345546302
27.396002334937013
```

```
outliers = [x for x in cotton_data['temperature'] if (x<lower) or (x>upper)]
outliers
```

```
[]
```

Training and Testing

```
independent = data[['Nitrogen', 'Phosphorous','Potassium','temperature', 'humidity', 'ph', 'rainfall
independent.head()
```

	Nitrogen	Phosphorous	Potassium	temperature	humidity	ph	rainfall
0	90.0	42.0	43.0	20.879744	82.002744	6.502985	202.935536
1	85.0	58.0	41.0	21.770462	80.319644	7.038096	226.655537
3	60.0	55.0	44.0	23.004459	82.320763	7.840207	263.964248
4	74.0	35.0	40.0	26.491096	80.158363	6.980401	242.864034
5	78.0	42.0	42.0	20.130175	81.604873	7.628473	262.717340

```
dependent = data[['Crop']]
dependent.head()
```

	Crop
0	rice
1	rice
3	rice
4	rice
5	rice

```
model = []        # Model names
accuracy = []     # Accuracy of the respective model
```

```
Xtrain, Xtest, Ytrain, Ytest = train_test_split(independent, dependent, test_size = 0.2, random_stat

print("Length of X_train is %s" % (len(Xtrain)))
print("Length of X_test is %s" % (len(Xtest)))
print("Length of Y_train is %s" % (len(Ytrain)))
print("Length of Y_test is %s" % (len(Ytest)))
```

```
Length of X_train is 1760
Length of X_test is 440
Length of Y_train is 1760
Length of Y_test is 440
```

```
Ytrain.value_counts()
```

```
Crop
apple          87
kidneybeans    86
watermelon     85
rice           84
blackgram      84
pomegranate    83
banana         83
grapes         82
pigeonpeas     82
mothbeans      81
papaya         81
cotton         80
maize          79
coconut        79
chickpea       79
coffee         78
muskmelon      77
lentil         77
mungbean       76
mango          74
jute           72
orange         71
dtype: int64
```

Logistic Regression

```
from sklearn.linear_model import LogisticRegression
from sklearn import metrics
from sklearn.metrics import classification_report
from sklearn.model_selection import cross_val_score
```

```
LogReg = LogisticRegression(random_state=2)
LogReg.fit(Xtrain,Ytrain)
predicted_values = LogReg.predict(Xtest)
x = metrics.accuracy_score(Ytest, predicted_values)
model.append('Logistic Regression')
accuracy.append(x*100)
print(classification_report(Ytest, predicted_values))
print("Logistic Regression's Accuracy is: ", x*100)
```

```
score_LR = cross_val_score(LogReg, independent, dependent, cv=5)
score_LR
```

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)
model.append('Decision Tree')
accuracy.append(x*100)
print(classification_report(Ytest, predicted_values))
print("Decision Trees' Accuracy is: ", x*100)
```

```
score_DT = cross_val_score(DecisionTree, independent, dependent, cv=5)
score_DT
```

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)
accuracy.append(x*100)
model.append('Random Forest')
print(classification_report(Ytest,predicted_values))
print("RF's Accuracy is: ", x*100)
```

```
score_RF = cross_val_score(RF,independent,dependent,cv=5)
score_RF
```

```
plt.figure(figsize=(8,4))
plt.title('Accuracy Comparison')
sns.barplot(x=model, y=accuracy, palette='Paired')
```

Predicting Results

Example 1

```
test_data = np.array([[80, 20, 30, 21.364, 55.127, 6.3, 120.21]])
prediction = LogReg.predict(test_data)
print(prediction)
```

```
test_data = np.array([[80, 20, 30, 21.364, 55.127, 6.3, 120.21]])
prediction = DecisionTree.predict(test_data)
print(prediction)
```

```
test_data = np.array([[80, 20, 30, 21.364, 55.127, 6.3, 120.21]])
prediction = RF.predict(test_data)
print(prediction)
```

Example 2

```
test_data = np.array([[93, 41, 40, 20.87, 82.032, 6.5, 205.9]])
prediction = LogReg.predict(test_data)
print(prediction)
```

```
test_data = np.array([[93, 41, 40, 20.87, 82.032, 6.5, 205.9]])
prediction = DecisionTree.predict(test_data)
print(prediction)
```

```
test_data = np.array([[93, 41, 40, 20.87, 82.032, 6.5, 205.9]])
prediction = RF.predict(test_data)
print(prediction)
```