AgriculturalProduction Optimization Engine

```
#for data manipulations
import numpy as np import
pandas as pd

#for data visualizations import
matplotlib.pyplot as plt import
seaborn as sns

#for interactive analysis from
ipywidgets import interact
#Reading the dataset data =
pd.read_csv('data.csv')
#Shape of the dataset
print("Shape of the dataset :", data.shape)
Shape of the dataset : (2200, 8)
#Checking the head of the dataset data.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

```
#Checking the missing values data.isnull().sum()
N               0
P               0 K
0 temperature    0
humidity        0
ph              0
rainfall        0
label           0
dtype: int64
#Checking the crops present
data['label'].value_counts()
coconut         100 lentil
100 apple           100
chickpea        100 banana
100
maize           100
kidneybeans     100
```

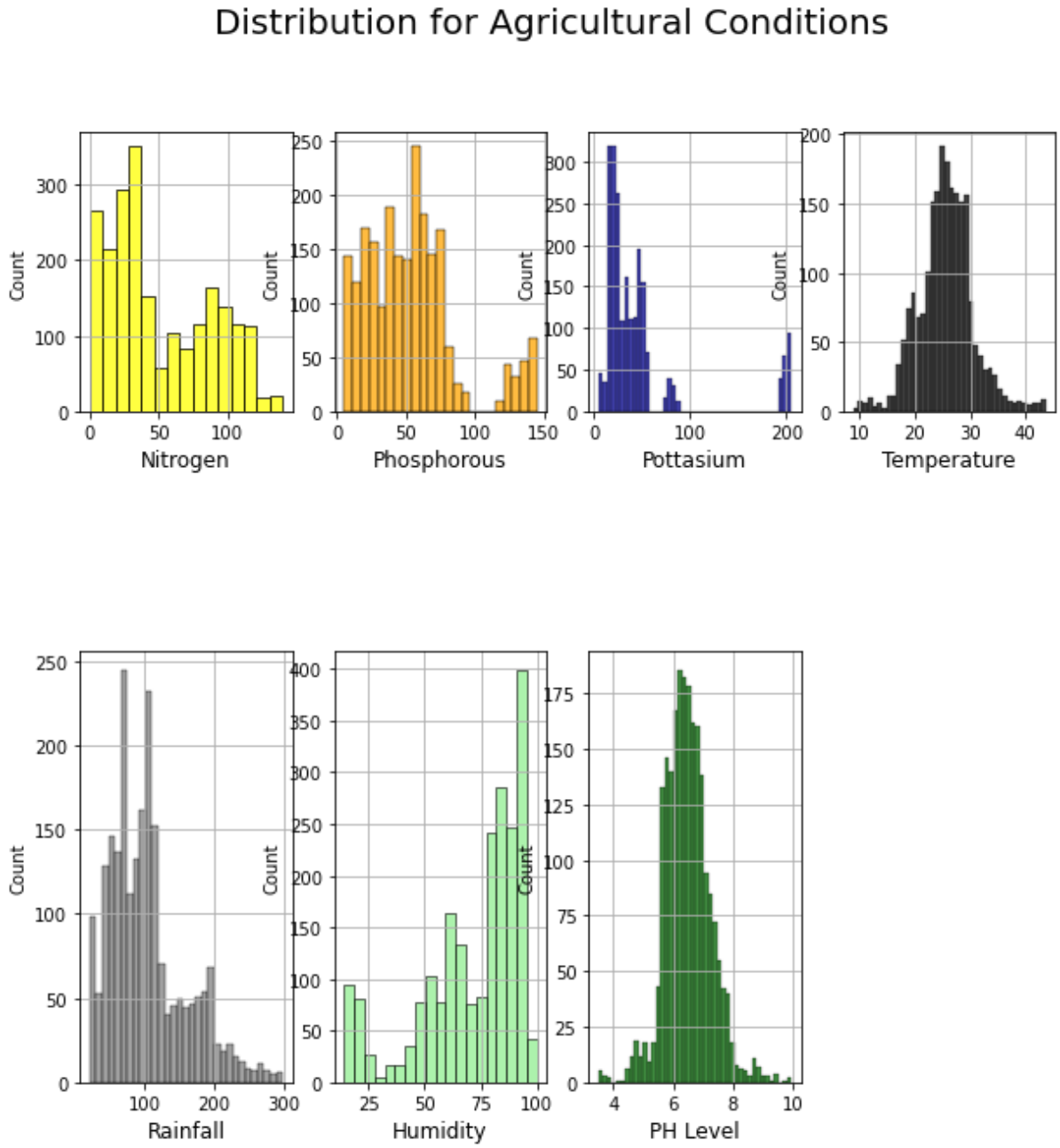
```
pomegranate    100
blackgram      100
pigeonpeas     100 jute
100 grapes         100
cotton         100
papaya         100
coffee         100
mango          100
watermelon     100
mungbean       100
mothbeans      100
muskmelon      100
orange         100 rice
100
Name: label, dtype: int64
#Checking average climatic and soil requirements
 print(" Average Ratio of Nitrogen in the Soil
:
{0:.2f}".format(data['N'].mean())) print(" Average
Ratio of Phosphorous in the Soil :
{0:.2f}".format(data['P'].mean())) print("
Average Ratio of Potassium in the Soil :
{0:.2f}".format(data['K'].mean())) print(" Average Temperature in Celsius
: {0:.2f}".format(data['temperature'].mean())) print(" Average Relative
Humidity in % : {0:.2f}".format(data['humidity'].mean())) print(" Average
PH Value of the Soil : {0:.2f}".format(data['ph'].mean())) print(" Average
Rainfall in mm : {0:.2f}".format(data['rainfall'].mean()))
 Average Ratio of Nitrogen in the Soil : 50.55
 Average Ratio of Phosphorous in the Soil : 53.36
 Average Ratio of Potassium in the Soil : 48.15
 Average Temperature in Celsius : 25.62
 Average Relative Humidity in % : 71.48
 Average PH Value of the Soil : 6.47
 Average Rainfall in mm : 103.46
#Checking the detailed statistics for each crop
 @interact def summary(crops =
list(data['label'].value_counts().index)):
    x = data[data['label'] == crops]
    print(".........................................")
print("Statistics for Nitrogen")     print("Minimum
Nitrogen required:", x['N'].min())     print("Average
Nitrogen required:", x['N'].mean())     print("Maximum
Nitrogen required:", x['N'].max())
print(".........................................")
print("Statistics for Phosphorous")     print("Minimum
Phosphorous required:", x['P'].min())     print("Average
Phosphorous required:", x['P'].mean())     print("Maximum
Phosphorous required:", x['P'].max())
print(".........................................")
print("Statistics for Pottasium")
    print("Minimum Pottasium required:", x['K'].min())     print("Average
Pottasium required:", x['K'].mean())     print("Maximum Pottasium
```

```
required:", x['K'].max())
print(".....................................")     print("Statistics
for Temperature")     print("Minimum Temperature required:
{0:.2f}".format(x['temperature'].min()))     print("Average Temperature
required: {0:.2f}".format(x['temperature'].mean()))     print("Maximum
Temperature required: {0:.2f}".format(x['temperature'].max()))
print(".....................................")     print("Statistics
for Humidity")     print("Minimum Humidity required:
{0:.2f}".format(x['humidity'].min()))     print("Average Humidity required:
{0:.2f}".format(x['humidity'].mean()))     print("Maximum Humidity
required: {0:.2f}".format(x['humidity'].max()))
print(".....................................")     print("Statistics
for PH")     print("Minimum PH required: {0:.2f}".format(x['ph'].min()))
print("Average PH required: {0:.2f}".format(x['ph'].mean()))
print("Maximum PH required: {0:.2f}".format(x['ph'].max()))
print(".....................................")     print("Statistics
for Rainfall")     print("Minimum Rainfall required:
{0:.2f}".format(x['rainfall'].min()))     print("Average Rainfall required:
{0:.2f}".format(x['rainfall'].mean()))     print("Maximum Rainfall
required: {0:.2f}".format(x['rainfall'].max()))
interactive(children=(Dropdown(description='crops', options=('coconut', 'le
ntil', 'apple', 'chickpea', 'banana…
```

```
#Comparing Average requirement and conditions for each crop
 @interact def compare(conditions = ['N', 'P', 'K', 'temperature', 'ph',
'humidity',
'rainfall']):     print("Average Value for", conditions,
"is {0:.2f}".format(data[conditions].mean()))
print(".....................................")
print("Rice : {0:.2f}".format(data[(data['label'] ==
'rice')][conditions].mean()))     print("Black grams :
{0:.2f}".format(data[(data['label'] ==
'blackgram')][conditions].mean()))
    print("Banana : {0:.2f}".format(data[(data['label'] ==
'banana')][conditions].mean()))     print("Jute :
{0:.2f}".format(data[(data['label'] ==
'jute')][conditions].mean()))     print("Coconut :
{0:.2f}".format(data[(data['label'] ==
'coconut')][conditions].mean()))
    print("Apple : {0:.2f}".format(data[(data['label'] ==
'apple')][conditions].mean()))     print("Papaya :
{0:.2f}".format(data[(data['label'] ==
'papaya')][conditions].mean()))     print("Muskmelon :
{0:.2f}".format(data[(data['label'] ==
'muskmelon')][conditions].mean()))
    print("Grapes : {0:.2f}".format(data[(data['label'] ==
'grapes')][conditions].mean()))     print("Watermelon :
{0:.2f}".format(data[(data['label'] ==
'watermelon')][conditions].mean()))     print("Kidney Beans :
{0:.2f}".format(data[(data['label'] ==
'kidneybeans')][conditions].mean()))     print("Mung Beans :
{0:.2f}".format(data[(data['label'] ==
```

```
'mungbean')][conditions].mean()))     print("Oranges :
{0:.2f}".format(data[(data['label'] ==
'orange')][conditions].mean()))     print("Chick Peas :
{0:.2f}".format(data[(data['label'] ==
'chickpea')][conditions].mean()))     print("Lentils :
{0:.2f}".format(data[(data['label'] ==
'lentil')][conditions].mean()))     print("Cotton :
{0:.2f}".format(data[(data['label'] ==
'cotton')][conditions].mean()))     print("Maize :
{0:.2f}".format(data[(data['label'] ==
'maize')][conditions].mean()))     print("Moth Beans :
{0:.2f}".format(data[(data['label'] ==
'mothbeans')][conditions].mean()))     print("Pigeon Peas :
{0:.2f}".format(data[(data['label'] ==
'pigeonpeas')][conditions].mean()))     print("Mango :
{0:.2f}".format(data[(data['label'] ==
'mango')][conditions].mean()))     print("Pomegranate :
{0:.2f}".format(data[(data['label'] ==
'pomegranate')][conditions].mean()))     print("Coffee :
{0:.2f}".format(data[(data['label'] ==
'coffee')][conditions].mean()))
interactive(children=(Dropdown(description='conditions', options=('N', 'P',
'K', 'temperature', 'ph', 'humidit…

#Checking the below and above Average Conditions
 @interact def compare(conditions = ['N', 'P', 'K', 'temperature', 'ph',
'humidity',
'rainfall']):     print("Crops that require greater than average",
conditions, '\n')     print(data[data[conditions] >
data[conditions].mean()]['label'].unique())
print("........................................")     print("Crops
that require less than average", conditions, '\n')
print(data[data[conditions] <=
data[conditions].mean()]['label'].unique())
interactive(children=(Dropdown(description='conditions', options=('N', 'P',
'K', 'temperature', 'ph', 'humidit…

#Checking distributiion for each crop

plt.subplot(3,4,1) sns.histplot(data['N'],
color="yellow") plt.xlabel('Nitrogen',
fontsize = 12) plt.grid()
 plt.subplot(3,4,2)
sns.histplot(data['P'], color="orange")
plt.xlabel('Phosphorous', fontsize = 12)
plt.grid()  plt.subplot(3,4,3)
sns.histplot(data['K'],
color="darkblue")
plt.xlabel('Pottasium', fontsize = 12)
plt.grid()  plt.subplot(3,4,4)
sns.histplot(data['temperature'],
color="black") plt.xlabel('Temperature',
```

```
fontsize = 12) plt.grid()
plt.subplot(2,4,5)
sns.histplot(data['rainfall'],
color="grey") plt.xlabel('Rainfall',
fontsize = 12) plt.grid()
plt.subplot(2,4,6)
sns.histplot(data['humidity'],
color="lightgreen")
plt.xlabel('Humidity', fontsize = 12)
plt.grid()  plt.subplot(2,4,7)
sns.histplot(data['ph'],
color="darkgreen") plt.xlabel('PH
Level', fontsize = 12) plt.grid()
plt.suptitle('Distribution for
Agricultural Conditions', fontsize = 20)
plt.show()
```



#Checking that crops those have unusual requirements

```
print("Some Interesting Patterns")
print("........................................") print("Crops that
require very High Ratio of Nitrogen Content in Soil:", data[data['N'] >
120]['label'].unique()) print("Crops that require very High Ratio of
Phosphorous Content in Soil:", data[data['P'] > 100]['label'].unique())
print("Crops that require very High Ratio of Potassium Content in Soil:",
data[data['K'] > 200]['label'].unique())
print("Crops that require very High Rainfall:", data[data['rainfall'] >
200]['label'].unique()) print("Crops that require very Low Temperature:",
data[data['temperature']
```

```
< 10]['label'].unique()) print("Crops that require very High Temperature:",
data[data['temperature'] > 40]['label'].unique())
print("Crops that require very Low Humidity:", data[data['humidity'] <
20]['label'].unique()) print("Crops that require very Low
pH:", data[data['ph'] <
4]['label'].unique()) print("Crops that require very High
pH:", data[data['ph'] >
9]['label'].unique())
```

```
Some Interesting Patterns
.........................................
Crops that require very High Ratio of Nitrogen Content in Soil: ['cotton']
Crops that require very High Ratio of Phosphorous Content in Soil: ['grapes
' 'apple']
Crops that require very High Ratio of Potassium Content in Soil: ['grapes'
'apple']
Crops that require very High Rainfall: ['rice' 'papaya' 'coconut']
Crops that require very Low Temperature: ['grapes']
Crops that require very High Temperature: ['grapes' 'papaya']
Crops that require very Low Humidity: ['chickpea' 'kidneybeans']
Crops that require very Low pH: ['mothbeans'] Crops
that require very High pH: ['mothbeans']
```

```
#Checking which crop to be grown according to the season
 print("Summer Crops") print(data[(data['temperature'] >
30) & (data['humidity'] >
50)]['label'].unique())
print(".........................................")
print("Winter Crops") print(data[(data['temperature'] < 20)
& (data['humidity'] >
30)]['label'].unique())
print(".........................................")
print("Monsoon Crops") print(data[(data['rainfall'] >
200) & (data['humidity'] > 30)]['label'].unique())
```

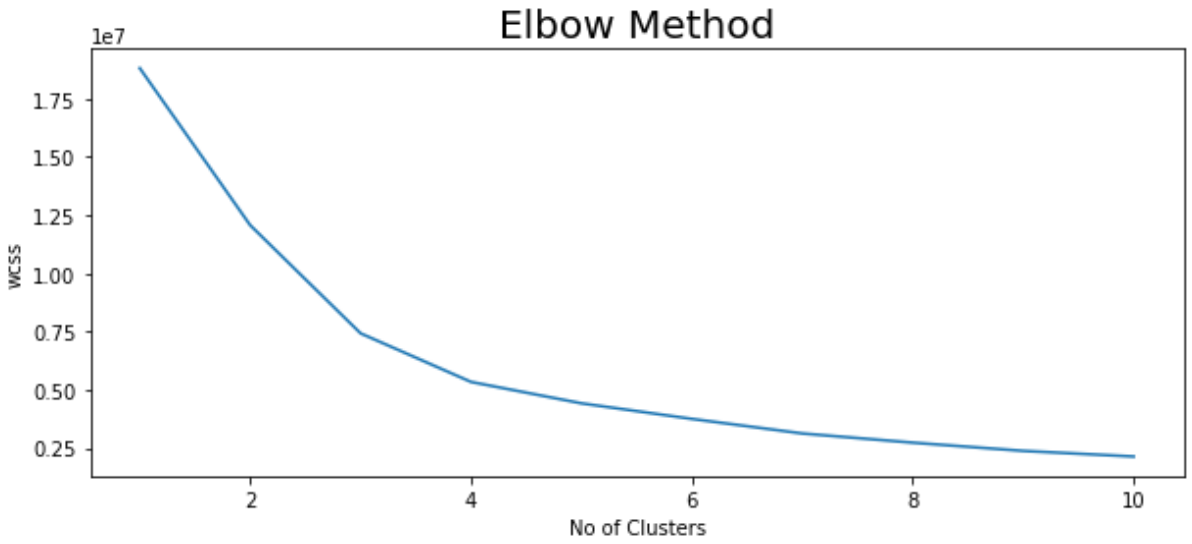
```
Summer Crops
['pigeonpeas' 'mothbeans' 'blackgram' 'mango' 'grapes' 'orange' 'papaya']
.........................................
Winter Crops
['maize' 'pigeonpeas' 'lentil' 'pomegranate' 'grapes' 'orange']
.........................................
Monsoon Crops
['rice' 'papaya' 'coconut']
```

```
 from sklearn.cluster import
KMeans

#removing the labels column x =
data.drop(['label'], axis=1)

#selecting all the values of data x
= x.values

#checking the shape print(x.shape)
```

```
(2200, 7)
```

```
#Determining the optimum number of clusters within the Dataset
plt.rcParams['figure.figsize'] = (10,4)
 wcss = [] for i in range(1,11):     km = KMeans(n_clusters = i, init = 'k-
means++', max_iter = 2000, n_init
= 10, random_state = 0)
km.fit(x)
wcss.append(km.inertia_)

#Plotting the results
 plt.plot(range(1,11), wcss)
plt.title('Elbow Method', fontsize = 20)
plt.xlabel('No of Clusters')
plt.ylabel('wcss') plt.show
```

```
<function matplotlib.pyplot.show(close=None, block=None)>
```




```
#Implementation of K Means algorithm to perform Clustering analysis
 km = KMeans(n_clusters = 4, init = 'k-means++',  max_iter = 2000, n_init
=
10, random_state = 0) y_means
= km.fit_predict(x)

#Finding the results a
= data['label']
y_means = pd.DataFrame(y_means) z =
pd.concat([y_means, a], axis = 1) z =
z.rename(columns = {0: 'cluster'})

#Checking the clusters for each crop print("Lets Check the results after
applying K Means Clustering Analysis
\n") print("Crops in First Cluster:", z[z['cluster'] ==
0]['label'].unique())
print(".....................................") print("Crops in
```

```
Second Cluster:", z[z['cluster'] == 1]['label'].unique())
print(".....................................")
print("Crops in Third Cluster:", z[z['cluster'] == 2]['label'].unique())
print(".....................................")
print("Crops in Fourth Cluster:", z[z['cluster'] == 3]['label'].unique())
```

Lets Check the results after applying K Means Clustering Analysis

```
Crops in First Cluster: ['maize' 'chickpea' 'kidneybeans' 'pigeonpeas' 'mot
hbeans' 'mungbean'
 'blackgram' 'lentil' 'pomegranate' 'mango' 'orange' 'papaya' 'coconut']
.....................................
Crops in Second Cluster: ['maize' 'banana' 'watermelon' 'muskmelon' 'papaya
' 'cotton' 'coffee']
.....................................
Crops in Third Cluster: ['grapes' 'apple']
.....................................
Crops in Fourth Cluster: ['rice' 'pigeonpeas' 'papaya' 'coconut' 'jute' 'co
ffee']
```

```
#Splitting the Dataset for predictive modelling
 y = data['label'] x =
data.drop(['label'], axis=1)
 print("Shape of x:",
x.shape) print("Shape of y:",
y.shape)
```

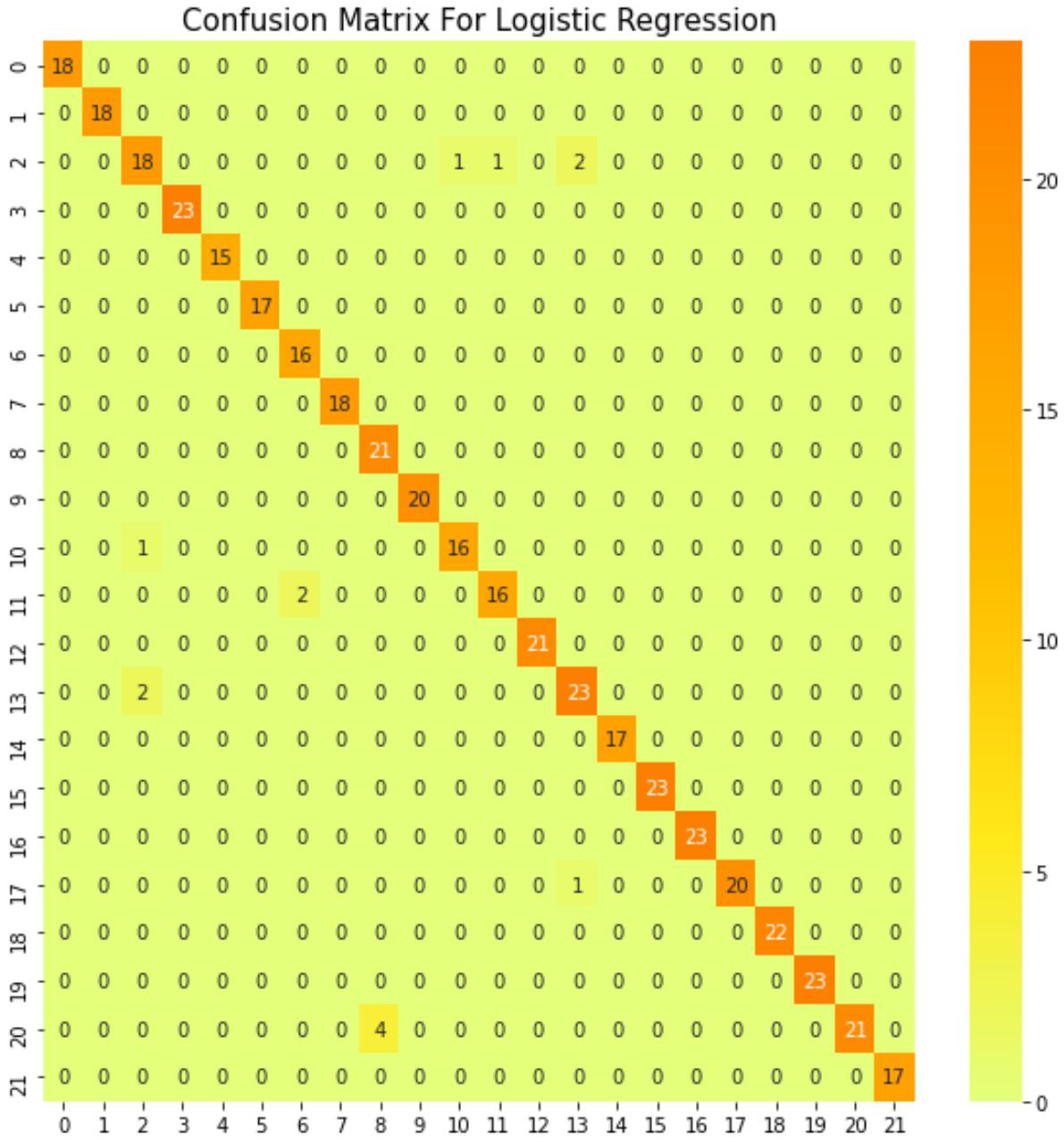
```
Shape of x: (2200, 7)
Shape of y: (2200,)
#Creating training and testing sets for results validation from
sklearn.model_selection import train_test_split
 x_train, x_test, y_train, y_test = train_test_split(x, y, test_size =
0.2, random_state = 0)
 print("The Shape Of x train:",
x_train.shape) print("The Shape Of x test:",
x_test.shape) print("The Shape Of y train:",
y_train.shape) print("The Shape Of y test:",
y_test.shape)
```

```
The Shape Of x train: (1760, 7)
The Shape Of x test: (440, 7)
The Shape Of y train: (1760,)
The Shape Of y test: (440,)
#Creating a Predictive Model
 from sklearn.linear_model import
LogisticRegression
 model = LogisticRegression()
model.fit(x_train, y_train)
y_pred = model.predict(x_test)
```

```
C:\Users\Deepesh\anaconda3\lib\site-packages\sklearn\linear_model\_logistic
.py:763: ConvergenceWarning: lbfgs failed to converge (status=1): 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-
regr ession   n_iter_i = _check_optimize_result(
```

```
#Evaluating the model performance
from sklearn.metrics import confusion_matrix
#Printing the Confusing Matrix plt.rcParams['figure.figsize'] =
(10,10) cm = confusion_matrix(y_test, y_pred) sns.heatmap(cm, annot
= True, cmap = 'Wistia') plt.title('Confusion Matrix For Logistic
Regression', fontsize = 15) plt.show()
```




```
#Defining the classification Report
```

```
from sklearn.metrics import classification_report
#Printing the Classification Report cr =
classification_report(y_test, y_pred) print(cr)
```

```
              precision    recall  f1-score   support
       apple       1.00      1.00      1.00
18      banana       1.00      1.00      1.00
18   blackgram       0.86      0.82      0.84
22    chickpea       1.00      1.00      1.00
23     coconut       1.00      1.00      1.00
15      coffee       1.00      1.00      1.00
17      cotton       0.89      1.00      0.94
16      grapes       1.00      1.00      1.00
18        jute       0.84      1.00      0.91
21  kidneybeans       1.00      1.00      1.00
20      lentil       0.94      0.94      0.94
17       maize       0.94      0.89      0.91
18       mango       1.00      1.00      1.00
21   mothbeans       0.88      0.92      0.90
25    mungbean       1.00      1.00      1.00
17   muskmelon       1.00      1.00      1.00
23      orange       1.00      1.00      1.00
23      papaya       1.00      0.95      0.98
21  pigeonpeas       1.00      1.00      1.00
22 pomegranate       1.00      1.00      1.00
23        rice       1.00      0.84      0.91
25  watermelon       1.00      1.00      1.00
17
    accuracy                           0.97
440    macro avg       0.97      0.97      0.97
440 weighted avg       0.97      0.97      0.97
440
```

```
#head of dataset data.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

```
prediction = model.predict((np.array([[90, 40, 40, 20, 80, 7, 200]])))
print("The Suggested Crop for given climatic condition is :",prediction)
The Suggested Crop for given climatic condition is : ['rice']
```