Crop Recommendation System — Colab Notebook

> **Dataset**: public Kaggle Crop Recommendation dataset

```
!pip install --quiet xgboost lightgbm shap lime imbalanced-learn scikit-optimize

print('Install step finished. Proceed to run the next cells.')
```

```
Install step finished. Proceed to run the next cells.
```

Double-click (or enter) to edit

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

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from pandas.plotting import scatter_matrix

from sklearn.model_selection import train_test_split, cross_val_score, GridSearchCV,
from sklearn.preprocessing import StandardScaler, LabelEncoder
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score,
from sklearn.pipeline import Pipeline

#models
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier



import requests
csv_path = '/content/Crop_recommendation.csv'

if not os.path.exists(csv_path):
    print('Downloading dataset from GitHub...')
    url = "https://raw.githubusercontent.com/aakashr02/Crop-Recommendation/main/data
    try:
        r = requests.get(url, timeout=30)
        r.raise_for_status()
        open(csv_path, 'wb').write(r.content)
        print('Downloaded to', csv_path)
    except Exception as e:
```

```
    print('Could not download automatically. Please upload the CSV manually to /
    print('Error:', e)


df = pd.read_csv(csv_path)
print('Dataset loaded. Shape:', df.shape)
df.head()
```

```
Dataset loaded. Shape: (2200, 8)
```

	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

EDA

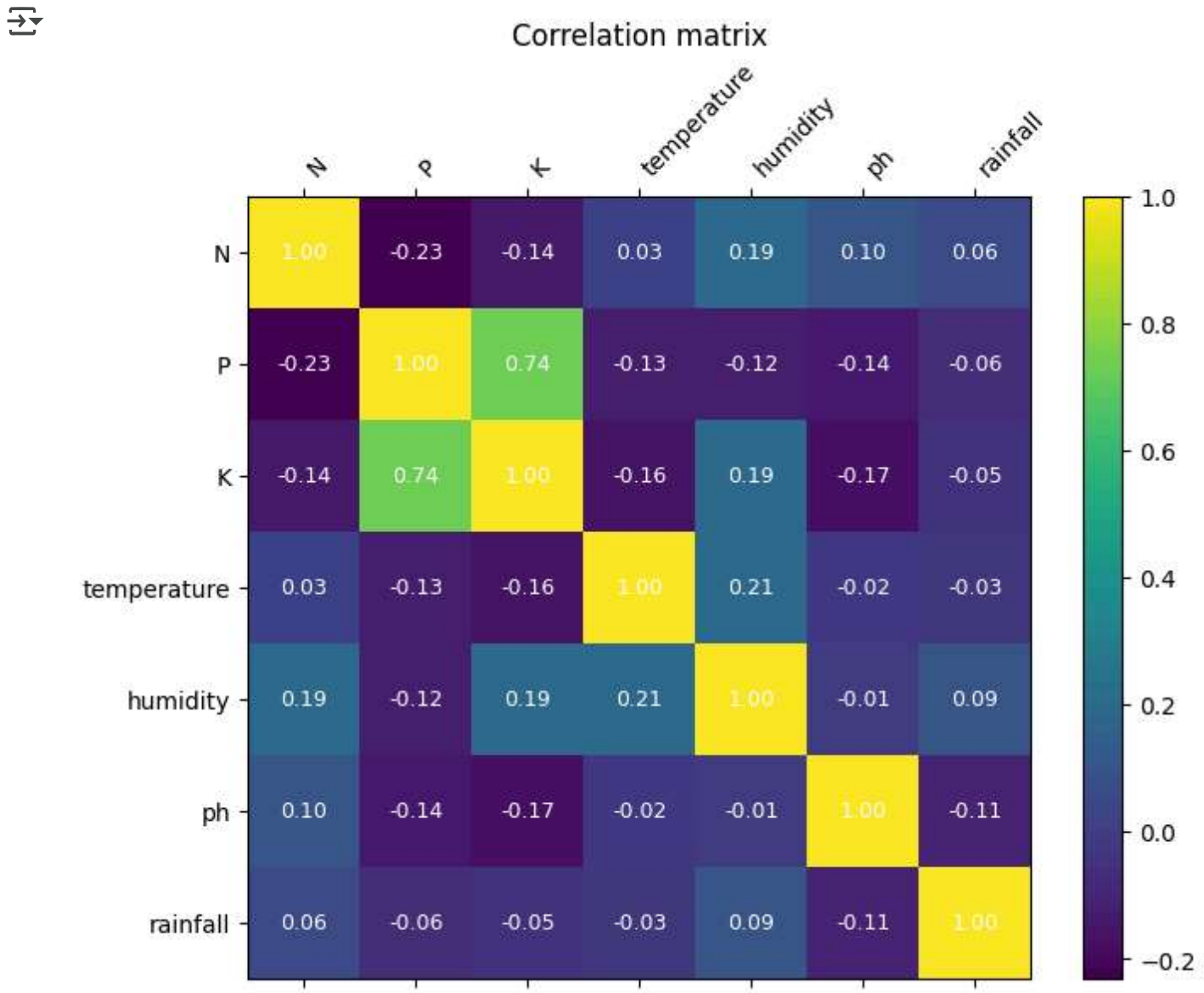
```
# Basic info & sanity checks
print('Columns:', df.columns.tolist())
print('\nInfo:')
display(df.info())
print('\nMissing values per column:')
print(df.isnull().sum())
print('\nValue counts for target label (sample):')
display(df['label'].value_counts().head(30))

print('\ndescriptive statistics:')
display(df.describe().T)
```

```
Columns: ['N', 'P', 'K', 'temperature', 'humidity', 'ph', 'rainfall', 'label']

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
None

Missing values per column:
N              0
P              0
K              0
temperature    0
humidity       0
ph             0
rainfall       0
label          0
dtype: int64

Value counts for target label (sample):
```

label	count
rice	100
maize	100
chickpea	100
kidneybeans	100
pigeonpeas	100
mothbeans	100
mungbean	100
blackgram	100
lentil	100
pomegranate	100
banana	100

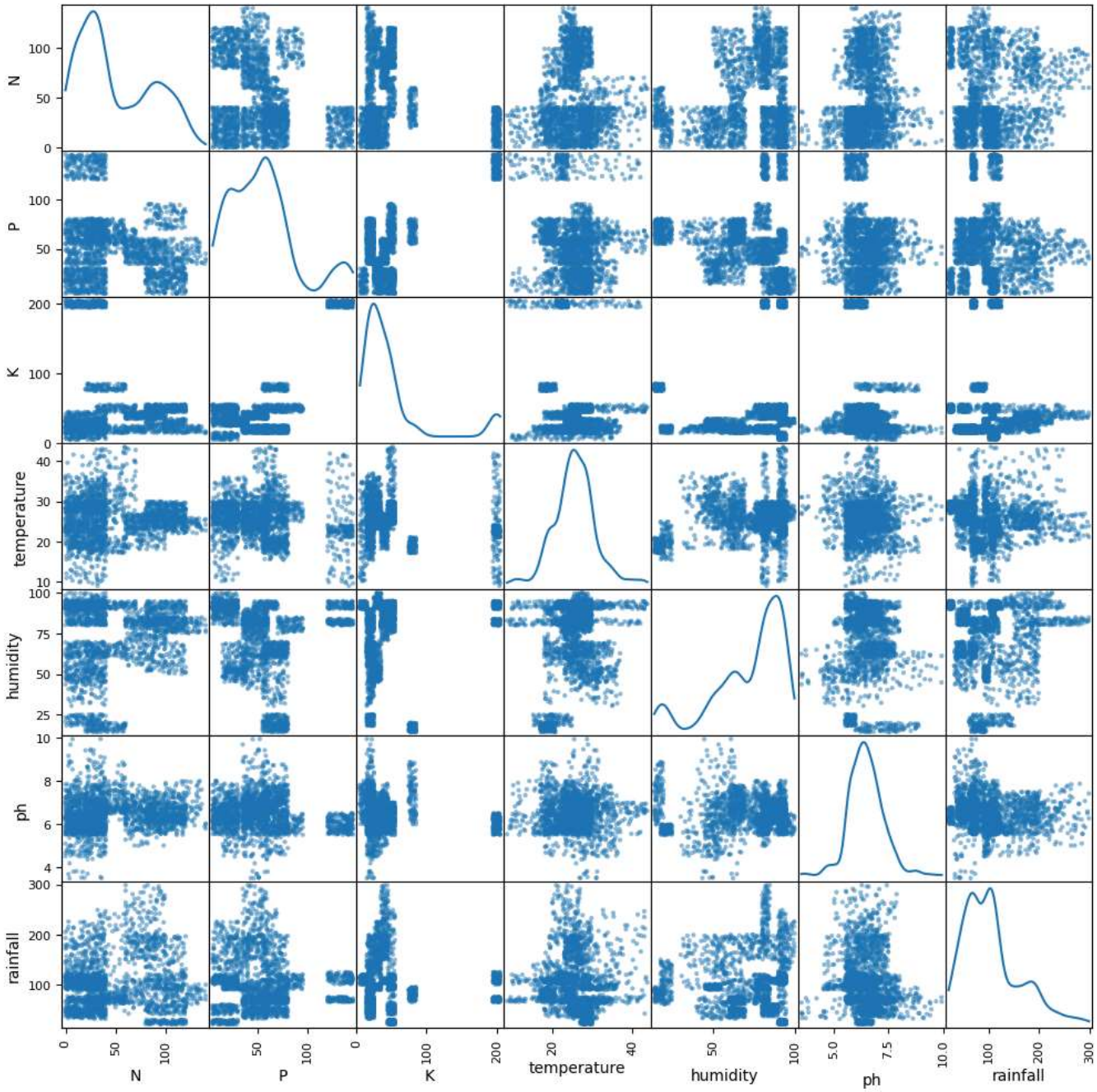
mango 100

```
# correlation matrix
num = df[['N','P','K','temperature','humidity','ph','rainfall']].corr()
fig, ax = plt.subplots(figsize=(8,6))
cax = ax.matshow(num, cmap='viridis')
fig.colorbar(cax)
ax.set_xticks(range(len(num.columns)))
ax.set_yticks(range(len(num.columns)))
ax.set_xticklabels(num.columns, rotation=45, ha='left')
ax.set_yticklabels(num.columns)


for (i, j), val in np.ndenumerate(num.values):
    ax.text(j, i, f"{val:.2f}", ha='center', va='center', color='white', fontsize=9)
plt.title('Correlation matrix')
plt.show()
```



```
# pair plot
scatter_matrix(df[num_cols], figsize=(12,12), diagonal='kde')
plt.suptitle('Scatter matrix of numeric predictors')
plt.show()
```

Scatter matrix of numeric predictors



```
# distribution of classes.
label_counts = df['label'].value_counts().sort_values(ascending=False)
print('Total classes:', label_counts.shape[0])
display(label_counts)
```

```
Total classes: 22
```

label	count
rice	100
maize	100
chickpea	100
kidneybeans	100
pigeonpeas	100
mothbeans	100
mungbean	100
blackgram	100
lentil	100
pomegranate	100
banana	100
mango	100
grapes	100
watermelon	100
muskmelon	100
apple	100
orange	100
papaya	100
coconut	100
cotton	100
jute	100
coffee	100

dtype: int64

Scale & standardizing and encoding

```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, LabelEncoder

X = df[['N','P','K','temperature','humidity','ph','rainfall']].copy()
y = df['label'].copy()

# Scale & standardizing and encoding
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)


le = LabelEncoder()
y_enc = le.fit_transform(y)
```

train_test_split

```
X_train, X_test, y_train, y_test = train_test_split(
    X_scaled, y_enc, test_size=0.2, random_state=42, stratify=y_enc
)

print('X_train shape:', X_train.shape)
print('X_test shape:', X_test.shape)
print('y_train shape:', y_train.shape)
print('y_test shape:', y_test.shape)
print('Preprocessing complete.')
```

```
X_train shape: (1760, 7)
X_test shape: (440, 7)
y_train shape: (1760,)
y_test shape: (440,)
Preprocessing complete.
```

MODELS TRAINING

```
from sklearn.metrics import accuracy_score, f1_score, classification_report

def train_eval_model(model, X_tr, y_tr, X_te, y_te, name='Model'):
    model.fit(X_tr, y_tr)
    y_pred = model.predict(X_te)
    acc = accuracy_score(y_te, y_pred)
    f1 = f1_score(y_te, y_pred, average='macro')

    print(f'--- {name} ---')
```

```
    print('Accuracy:', acc)
    print('F1 macro:', f1)
    # print('\nClassification report:')
    # print(classification_report(y_te, y_pred, target_names=le.classes_))

    return {'model': name, 'accuracy': acc, 'f1_macro': f1}


#Logistic Regression
log_reg = LogisticRegression(max_iter=1000)
res_lr = train_eval_model(log_reg, X_train, y_train, X_test, y_test, 'LogisticRegres
```

```
--- LogisticRegression ---
Accuracy: 0.9727272727272728
F1 macro: 0.9724640256149183
```

```
#KNN
knn = KNeighborsClassifier(n_neighbors=7)
res_knn = train_eval_model(knn, X_train, y_train, X_test, y_test, 'KNN')
```

```
--- KNN ---
Accuracy: 0.9704545454545455
F1 macro: 0.9701916027706396
```

```
#SVC
svc = SVC(probability=True, kernel='rbf')
res_svc = train_eval_model(svc, X_train, y_train, X_test, y_test, 'SVC')
```

```
--- SVC ---
Accuracy: 0.9840909090909091
F1 macro: 0.9840381050638686
```

```
#Random-Forest
rf = RandomForestClassifier(n_estimators=200, random_state=42)
res_rf = train_eval_model(rf, X_train, y_train, X_test, y_test, 'RandomForest')
```

```
--- RandomForest ---
Accuracy: 0.9954545454545455
F1 macro: 0.9954517027687758
```

```
# Collect results into a DataFrame for comparison
results = [res_lr, res_knn, res_svc, res_rf]
res_df = pd.DataFrame(results)[['model', 'accuracy', 'f1_macro']].sort_values('f1_ma
display(res_df)
```

	model	accuracy	f1_macro
3	RandomForest	0.995455	0.995452
2	SVC	0.984091	0.984038
0	LogisticRegression	0.972727	0.972464
1	KNN	0.970455	0.970192

XGBoost & LightGBM training

```
import xgboost as xgb
import lightgbm as lgb
import pandas as pd

final_results = []

# XGBoost

xgb_clf = xgb.XGBClassifier(
    use_label_encoder=False,
    eval_metric='mlogloss',
    random_state=42,
    n_jobs=1
)
res_xgb = train_eval_model(xgb_clf, X_train, y_train, X_test, y_test, 'XGBoost')
final_results.append(res_xgb)
```

```
--- XGBoost ---
Accuracy: 0.9931818181818182
F1 macro: 0.9931162119865586
```

LightGBM

```
lgb_clf = lgb.LGBMClassifier(random_state=42, n_jobs=1)
res_lgb = train_eval_model(lgb_clf, X_train, y_train, X_test, y_test, 'LightGBM')
final_results.append(res_lgb)
```

```
[LightGBM] [Info] Auto-choosing col-wise multi-threading, the overhead of testi
You can set `force_col_wise=true` to remove the overhead.
[LightGBM] [Info] Total Bins 1332
[LightGBM] [Info] Number of data points in the train set: 1760, number of used
[LightGBM] [Info] Start training from score -3.091042
[LightGBM] [Info] Start training from score -3.091042
[LightGBM] [Info] Start training from score -3.091042
[LightGBM] [Info] Start training from score -3.091042
[LightGBM] [Info] Start training from score -3.091042
```

```
[LightGBM] [Info] Start training from score -3.091042
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[LightGBM] [Info] Start training from score -3.091042
[LightGBM] [Info] Start training from score -3.091042
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```

```
if 'res_df' in globals():
    comp = res_df.copy()
    new_rows = [{'model': r['model'], 'accuracy': r['accuracy'], 'f1_macro': r['f1_m
                for r in final_results]
    if new_rows:
```

```
            comp = pd.concat([comp, pd.DataFrame(new_rows)], ignore_index=True)
        display(comp.sort_values('f1_macro', ascending=False))
    else:
        if final_results:
            comp = pd.DataFrame(final_results)[['model', 'accuracy', 'f1_macro']]
            display(comp.sort_values('f1_macro', ascending=False))
        else:
            print('No models evaluated; final_results is empty.')
```

	model	accuracy	f1_macro
0	RandomForest	0.995455	0.995452