Analyse Discriminante Quadratique - OVO

Analyse Discriminante Quadratique (QDA) - One-Versus-One (OVO)

Théorie

L'**Analyse Discriminante Quadratique (QDA)** est une technique de classification qui, contrairement à LDA, permet aux classes d'avoir des **matrices de covariance différentes**. Cela le rend plus flexible mais peut aussi augmenter le risque de sur-apprentissage.

L'approche **One-Versus-One (OVO)** consiste à entraîner un modèle pour chaque paire de classes, ce qui est utile lorsque les classes sont bien séparées.

Hyperparamètres

Nous allons tester les hyperparamètres suivants : - **Régularisation (`reg_param`)** : contrôle la variance de la covariance estimée (valeurs entre `0` et `1`). - **Standardisation des données** : normalisation des features avant l'entraînement.

Exemple en Python

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.discriminant_analysis import QuadraticDiscriminantAnalysis
from sklearn.multiclass import OneVsOneClassifier
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
```

```python
# Chargement des ensembles de données
train_data = pd.read_csv('covertype_train.csv')
val_data = pd.read_csv('covertype_val.csv')
test_data = pd.read_csv('covertype_test.csv')

# Préparation des données
X_train = train_data.drop('Cover_Type', axis=1)
y_train = train_data['Cover_Type']

X_val = val_data.drop('Cover_Type', axis=1)
y_val = val_data['Cover_Type']

X_test = test_data.drop('Cover_Type', axis=1)
y_test = test_data['Cover_Type']

# Standardisation des données
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_val = scaler.transform(X_val)
X_test = scaler.transform(X_test)

# Recherche des meilleurs hyperparamètres
reg_params = np.linspace(0, 1, 10)
train_accuracies = []
val_accuracies = []

for reg_param in reg_params:
    qda_ovo = OneVsOneClassifier(QuadraticDiscriminantAnalysis(reg_param=reg_param))
    qda_ovo.fit(X_train, y_train)

    y_train_pred = qda_ovo.predict(X_train)
    y_val_pred = qda_ovo.predict(X_val)

    train_accuracies.append(accuracy_score(y_train, y_train_pred))
    val_accuracies.append(accuracy_score(y_val, y_val_pred))

# Sélection du meilleur reg_param
best_reg_param = reg_params[val_accuracies.index(max(val_accuracies))]
print(f"Meilleur reg_param QDA (OVO): {best_reg_param}")

# Affichage du graphique
plt.figure(figsize=(8, 6))
```

```
plt.plot(reg_params, train_accuracies, marker='o', linestyle='dashed', label='Train Accuracy
plt.plot(reg_params, val_accuracies, marker='s', linestyle='dashed', label='Validation Accura
plt.xlabel("Régularisation (reg_param)")
plt.ylabel("Précision")
plt.title("Impact de la régularisation sur la performance de QDA (OVO)")
plt.legend()
plt.show()

# Modèle final avec le meilleur reg_param
qda_ovo = OneVsOneClassifier(QuadraticDiscriminantAnalysis(reg_param=best_reg_param))
qda_ovo.fit(X_train, y_train)
y_test_pred = qda_ovo.predict(X_test)

# Affichage de la matrice de confusion
conf_matrix = confusion_matrix(y_test, y_test_pred)
print("\nMatrice de confusion (OVO) :")
print(conf_matrix)

print("\nÉvaluation sur l'ensemble de test")
print(classification_report(y_test, y_test_pred))
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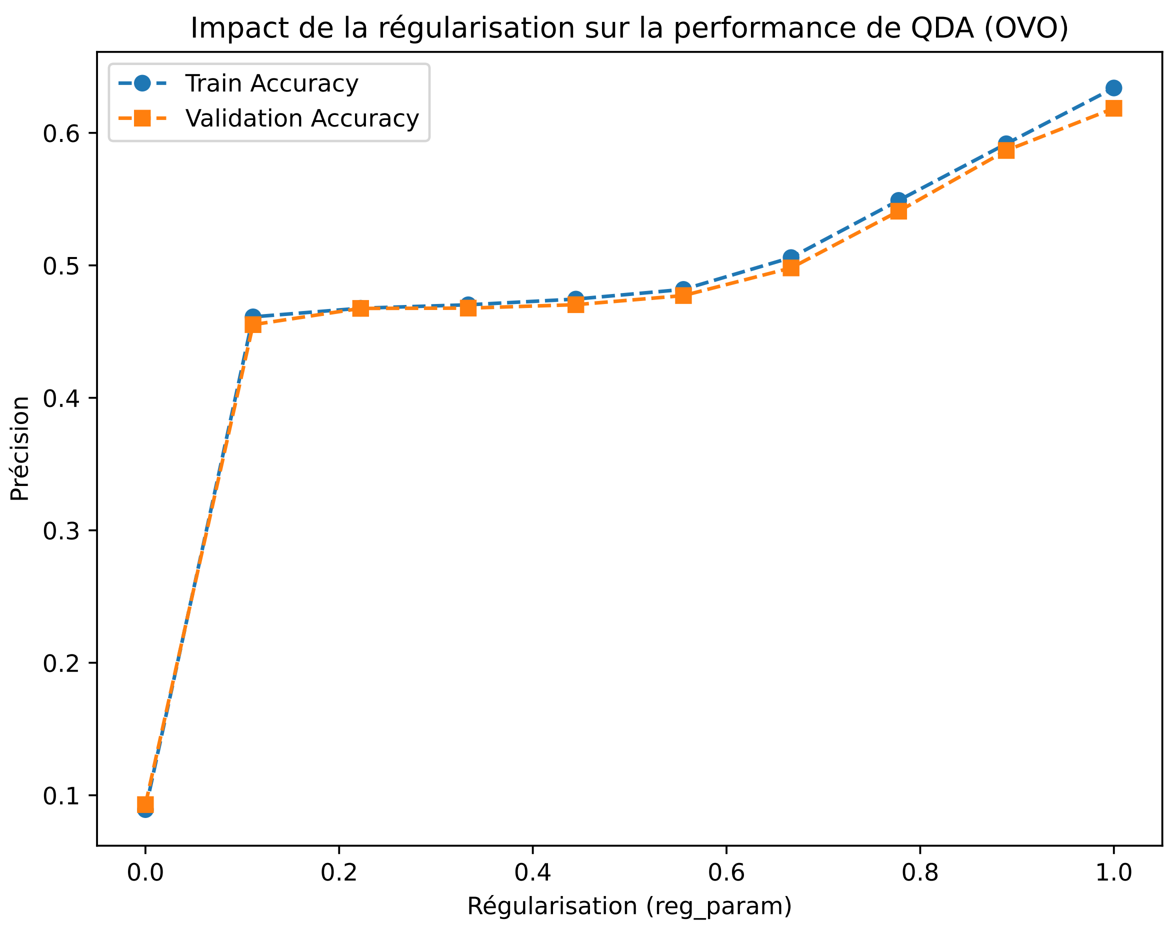
```
Meilleur reg_param QDA (OVO): 1.0
```



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Matrice de confusion (OVO) :
[[ 827  670    0    0   22    4  185]
 [ 329 1731   30   12   76   73   10]
 [   0   12  132   16   27   94    0]
 [   0    0    5   12    0    4    0]
 [   5   40    8    0   19    2    0]
 [   0   24   48    2    9   61    0]
 [  17    7    0    0    0    0  135]]

Évaluation sur l'ensemble de test
              precision    recall  f1-score   support

           1       0.70      0.48      0.57      1708
           2       0.70      0.77      0.73      2261
           3       0.59      0.47      0.52       281
           4       0.29      0.57      0.38        21
           5       0.12      0.26      0.17        74
           6       0.26      0.42      0.32       144
           7       0.41      0.85      0.55       159
```

```
    accuracy                           0.63      4648
   macro avg       0.44      0.55      0.46      4648
weighted avg       0.66      0.63      0.63      4648

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