ensamble-learning

December 10, 2023

[104]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.ensemble import RandomForestClassifier, VotingClassifier,␣
 ↪BaggingClassifier, ExtraTreesClassifier
from sklearn.ensemble import BaggingRegressor, RandomForestRegressor,␣
 ↪ExtraTreesRegressor
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression, LinearRegression
from sklearn.model_selection import GridSearchCV
from sklearn.preprocessing import StandardScaler
```

[105]:
```
df = pd.read_csv("/kaggle/input/diabetes-dataset/diabetes.csv")
df.head()
```

[105]:
```
   Pregnancies  Glucose  BloodPressure  SkinThickness  Insulin   BMI  \
0            6      148             72             35        0  33.6
1            1       85             66             29        0  26.6
2            8      183             64              0        0  23.3
3            1       89             66             23       94  28.1
4            0      137             40             35      168  43.1

   DiabetesPedigreeFunction  Age  Outcome
0                     0.627   50        1
1                     0.351   31        0
2                     0.672   32        1
3                     0.167   21        0
4                     2.288   33        1
```

[106]:
```
df.shape
```

[106]:
```
(768, 9)
```

[107]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Pregnancies               768 non-null    int64
 1   Glucose                   768 non-null    int64
 2   BloodPressure             768 non-null    int64
 3   SkinThickness             768 non-null    int64
 4   Insulin                   768 non-null    int64
 5   BMI                       768 non-null    float64
 6   DiabetesPedigreeFunction  768 non-null    float64
 7   Age                       768 non-null    int64
 8   Outcome                   768 non-null    int64
dtypes: float64(2), int64(7)
memory usage: 54.1 KB
```

[108]:
```
df.isnull().sum()
```

[108]:
```
Pregnancies                 0
Glucose                     0
BloodPressure               0
SkinThickness               0
Insulin                     0
BMI                         0
DiabetesPedigreeFunction    0
Age                         0
Outcome                     0
dtype: int64
```

[109]:
```
df.describe()
```

[109]:
```
       Pregnancies     Glucose  BloodPressure  SkinThickness     Insulin  \
count   768.000000  768.000000     768.000000     768.000000  768.000000
mean      3.845052  120.894531      69.105469      20.536458   79.799479
std       3.369578   31.972618      19.355807      15.952218  115.244002
min       0.000000    0.000000       0.000000       0.000000    0.000000
25%       1.000000   99.000000      62.000000       0.000000    0.000000
50%       3.000000  117.000000      72.000000      23.000000   30.500000
75%       6.000000  140.250000      80.000000      32.000000  127.250000
max      17.000000  199.000000     122.000000      99.000000  846.000000

              BMI  DiabetesPedigreeFunction         Age     Outcome
count  768.000000                768.000000  768.000000  768.000000
mean    31.992578                  0.471876   33.240885    0.348958
std      7.884160                  0.331329   11.760232    0.476951
min      0.000000                  0.078000   21.000000    0.000000
25%     27.300000                  0.243750   24.000000    0.000000
50%     32.000000                  0.372500   29.000000    0.000000
75%     36.600000                  0.626250   41.000000    1.000000
```

```
max     67.100000                  2.420000   81.000000    1.000000
```

[110]:

```
categorical_val = []
continous_val = []
for column in df.columns:
    if len(df[column].unique()) <= 10:
        categorical_val.append(column)
    else:
        continous_val.append(column)
```

[111]:

```
df.columns
```

[111]:

```
Index(['Pregnancies', 'Glucose', 'BloodPressure', 'SkinThickness', 'Insulin',
       'BMI', 'DiabetesPedigreeFunction', 'Age', 'Outcome'],
      dtype='object')
```

[112]:

```
feature_columns = [
    'Pregnancies', 'Glucose', 'BloodPressure', 'SkinThickness',
    'Insulin', 'BMI', 'DiabetesPedigreeFunction', 'Age'
]

for column in feature_columns:
    print(f"column, {column} ==> Missing zeros : {len(df.loc[df[column] ==␣
 ↪0])}")
```

```
column, Pregnancies ==> Missing zeros : 111
column, Glucose ==> Missing zeros : 5
column, BloodPressure ==> Missing zeros : 35
column, SkinThickness ==> Missing zeros : 227
column, Insulin ==> Missing zeros : 374
column, BMI ==> Missing zeros : 11
column, DiabetesPedigreeFunction ==> Missing zeros : 0
column, Age ==> Missing zeros : 0
```

[113]:

```
from sklearn.impute import SimpleImputer
fill_values = SimpleImputer(missing_values=0, strategy="mean", copy=False)
df[feature_columns] = fill_values.fit_transform(df[feature_columns])

for column in feature_columns:
    print(f"column,{column} ==> Missing zeros : {len(df.loc[df[column] == 0])}")
```

```
column,Pregnancies ==> Missing zeros : 0
column,Glucose ==> Missing zeros : 0
column,BloodPressure ==> Missing zeros : 0
column,SkinThickness ==> Missing zeros : 0
column,Insulin ==> Missing zeros : 0
column,BMI ==> Missing zeros : 0
```

```
column,DiabetesPedigreeFunction ==> Missing zeros : 0
column,Age ==> Missing zeros : 0
```

[114]:

```python
X = df[feature_columns]
y = df.Outcome
```

[115]:

```python
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)
```

[116]:

```python
from sklearn.metrics import confusion_matrix, accuracy_score, classification_report


def evaluate(model, X_train, X_test, y_train, y_test):
    y_test_pred = model.predict(X_test)
    y_train_pred = model.predict(X_train)

    print("TRAINIG RESULTS: \n===============================")
    clf_report = pd.DataFrame(classification_report(y_train, y_train_pred, output_dict=True))
    print(f"CONFUSION MATRIX:\n{confusion_matrix(y_train, y_train_pred)}")
    print(f"ACCURACY SCORE:\n{accuracy_score(y_train, y_train_pred):.4f}")
    print(f"CLASSIFICATION REPORT:\n{clf_report}")

    print("TESTING RESULTS: \n===============================")
    clf_report = pd.DataFrame(classification_report(y_test, y_test_pred, output_dict=True))
    print(f"CONFUSION MATRIX:\n{confusion_matrix(y_test, y_test_pred)}")
    print(f"ACCURACY SCORE:\n{accuracy_score(y_test, y_test_pred):.4f}")
    print(f"CLASSIFICATION REPORT:\n{clf_report}")
```

Bagging Algorithms

[117]:

```python
from sklearn.ensemble import BaggingClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
rf_clf = RandomForestClassifier(random_state=42, n_estimators=1000)
rf_clf.fit(X_train, y_train)
evaluate(rf_clf, X_train, X_test, y_train, y_test)
```

```
TRAINIG RESULTS:
===============================
CONFUSION MATRIX:
[[349   0]
 [  0 188]]
ACCURACY SCORE:
1.0000
```

```
CLASSIFICATION REPORT:
               0      1  accuracy  macro avg  weighted avg
precision    1.0    1.0       1.0        1.0           1.0
recall       1.0    1.0       1.0        1.0           1.0
f1-score     1.0    1.0       1.0        1.0           1.0
support    349.0  188.0       1.0      537.0         537.0
TESTING RESULTS:
===============================
CONFUSION MATRIX:
[[123  28]
 [ 29  51]]
ACCURACY SCORE:
0.7532
CLASSIFICATION REPORT:
                    0          1  accuracy   macro avg  weighted avg
precision    0.809211   0.645570  0.753247    0.727390      0.752538
recall       0.814570   0.637500  0.753247    0.726035      0.753247
f1-score     0.811881   0.641509  0.753247    0.726695      0.752878
support    151.000000  80.000000  0.753247  231.000000    231.000000
```

[118]:

```python
from sklearn.ensemble import BaggingClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier

# Create a BaggingClassifier
base_classifier = DecisionTreeClassifier()
bagging_clf = BaggingClassifier(base_classifier, n_estimators=10,␣
 ↪random_state=42)

# Fit the BaggingClassifier
bagging_clf.fit(X_train, y_train)

# Calculate and store accuracy scores for Bagging Classifier
bagging_scores = {
    'Train': accuracy_score(y_train, bagging_clf.predict(X_train)),
    'Test': accuracy_score(y_test, bagging_clf.predict(X_test)),
}

# Calculate and store accuracy scores for Bagging Classifier
scores = {
    'Bagging Classifier': {
        'Train': accuracy_score(y_train, bagging_clf.predict(X_train)),
        'Test': accuracy_score(y_test, bagging_clf.predict(X_test)),
    },
}
```

```
# Calculate and store accuracy scores for Random Forest
scores['Random Forest'] = {
    'Train': accuracy_score(y_train, rf_clf.predict(X_train)),
    'Test': accuracy_score(y_test, rf_clf.predict(X_test)),
}
```

Boosting Algorithms

[119]:

```
from sklearn.ensemble import AdaBoostClassifier

ada_boost_clf = AdaBoostClassifier(n_estimators=30)
ada_boost_clf.fit(X_train, y_train)
evaluate(ada_boost_clf, X_train, X_test, y_train, y_test)
```

```
TRAINIG RESULTS:
===============================
CONFUSION MATRIX:
[[310  39]
 [ 51 137]]
ACCURACY SCORE:
0.8324
CLASSIFICATION REPORT:
                    0           1  accuracy   macro avg  weighted avg
precision    0.858726    0.778409  0.832402    0.818567      0.830607
recall       0.888252    0.728723  0.832402    0.808488      0.832402
f1-score     0.873239    0.752747  0.832402    0.812993      0.831056
support    349.000000  188.000000  0.832402  537.000000    537.000000
TESTING RESULTS:
===============================
CONFUSION MATRIX:
[[123  28]
 [ 27  53]]
ACCURACY SCORE:
0.7619
CLASSIFICATION REPORT:
                    0          1  accuracy   macro avg  weighted avg
precision    0.820000   0.654321  0.761905    0.737160      0.762622
recall       0.814570   0.662500  0.761905    0.738535      0.761905
f1-score     0.817276   0.658385  0.761905    0.737830      0.762249
support    151.000000  80.000000  0.761905  231.000000    231.000000
```

[120]:

```
scores['AdaBoost'] = {
        'Train': accuracy_score(y_train, ada_boost_clf.predict(X_train)),
        'Test': accuracy_score(y_test, ada_boost_clf.predict(X_test)),
    }
```

[121]:

```
from sklearn.ensemble import GradientBoostingClassifier

grad_boost_clf = GradientBoostingClassifier(n_estimators=100, random_state=42)
grad_boost_clf.fit(X_train, y_train)
evaluate(grad_boost_clf, X_train, X_test, y_train, y_test)
```

```
TRAINIG RESULTS:
===============================
CONFUSION MATRIX:
[[342   7]
 [ 19 169]]
ACCURACY SCORE:
0.9516
CLASSIFICATION REPORT:
                   0           1  accuracy   macro avg  weighted avg
precision   0.947368    0.960227  0.951583    0.953798      0.951870
recall      0.979943    0.898936  0.951583    0.939439      0.951583
f1-score    0.963380    0.928571  0.951583    0.945976      0.951194
support   349.000000  188.000000  0.951583  537.000000    537.000000
TESTING RESULTS:
===============================
CONFUSION MATRIX:
[[116  35]
 [ 26  54]]
ACCURACY SCORE:
0.7359
CLASSIFICATION REPORT:
                   0          1  accuracy   macro avg  weighted avg
precision   0.816901   0.606742  0.735931    0.711821      0.744119
recall      0.768212   0.675000  0.735931    0.721606      0.735931
f1-score    0.791809   0.639053  0.735931    0.715431      0.738906
support   151.000000  80.000000  0.735931  231.000000    231.000000
```

[122]:

```
scores['Gradient Boosting'] = {
        'Train': accuracy_score(y_train, grad_boost_clf.predict(X_train)),
        'Test': accuracy_score(y_test, grad_boost_clf.predict(X_test)),
    }
```

[123]:

```
from sklearn.ensemble import VotingClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score

# Define classifiers
log_reg = LogisticRegression(solver='liblinear')
```

```
tree = DecisionTreeClassifier()
svm_clf = SVC(gamma='scale')

estimators = [('Logistic', log_reg), ('Tree', tree), ('SVM', svm_clf)]

voting = VotingClassifier(estimators=estimators)
voting.fit(X_train, y_train)
evaluate(voting, X_train, X_test, y_train, y_test)
```

```
TRAINIG RESULTS:
===============================
CONFUSION MATRIX:
[[327  22]
 [ 82 106]]
ACCURACY SCORE:
0.8063
CLASSIFICATION REPORT:
                    0           1  accuracy   macro avg  weighted avg
precision    0.799511    0.828125  0.806331    0.813818      0.809529
recall       0.936963    0.563830  0.806331    0.750396      0.806331
f1-score     0.862797    0.670886  0.806331    0.766841      0.795610
support    349.000000  188.000000  0.806331  537.000000    537.000000
TESTING RESULTS:
===============================
CONFUSION MATRIX:
[[131  20]
 [ 36  44]]
ACCURACY SCORE:
0.7576
CLASSIFICATION REPORT:
                    0          1  accuracy   macro avg  weighted avg
precision    0.784431   0.687500  0.757576    0.735966      0.750862
recall       0.867550   0.550000  0.757576    0.708775      0.757576
f1-score     0.823899   0.611111  0.757576    0.717505      0.750206
support    151.000000  80.000000  0.757576  231.000000    231.000000
```

[124]:

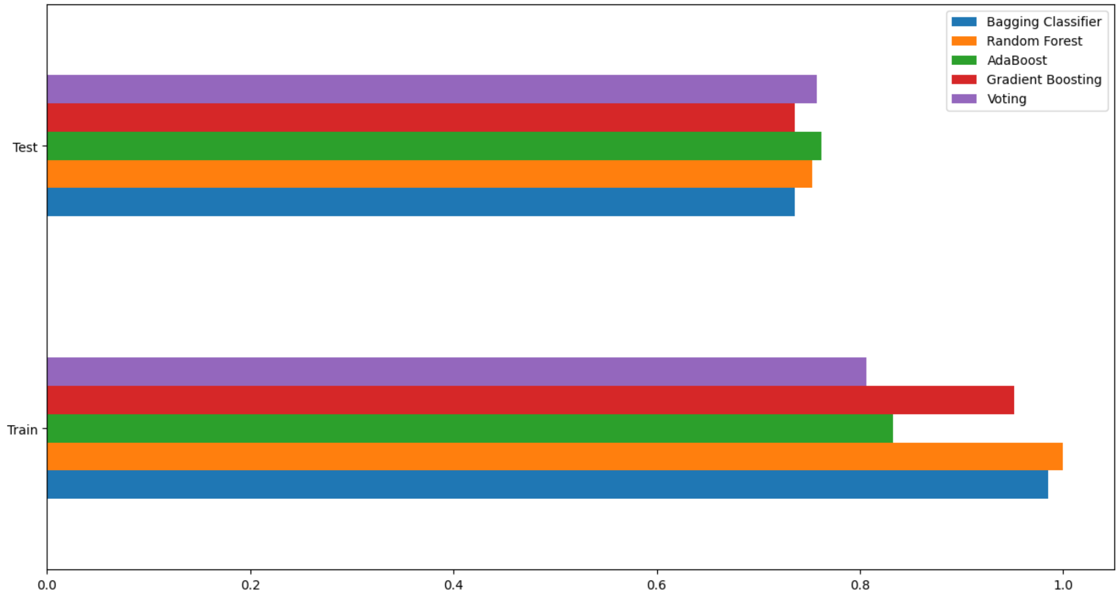
```
scores['Voting'] = {
        'Train': accuracy_score(y_train, voting.predict(X_train)),
        'Test': accuracy_score(y_test, voting.predict(X_test)),
    }
```

[125]:

```
scores_df = pd.DataFrame(scores)
scores_df.plot(kind='barh', figsize=(15, 8))
```

[125]:

```
<Axes: >
```


Bagging Classifier
Random Forest
AdaBoost
Gradient Boosting
Voting
Test
Train
0.0
0.2
0.4
0.6
0.8
1.0