Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Small data technique

Practice Session 15

Changho Suh

January 26, 2024

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Outline

Implementation of **random forests**

Tasks: Iris plants classification
California housing price prediction
Handwritten digit classification

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Random forests for Iris plants classification

```
from sklearn.datasets import load_iris
Iris = load_iris()
X = Iris.data
y = Iris.target
```

```
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
```

```
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2)
```

```
rnd_clf = RandomForestClassifier(n_estimators=500, max_leaf_nodes=16, n_jobs=-1)
```

use all available CPU's

```
rnd_clf.fit(X_train, y_train)
```

```
y_pred = rnd_clf.predict(X_test)
print(rnd_clf.score(X_test,y_test))
```

```
0.9666666666666667
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Feature importance

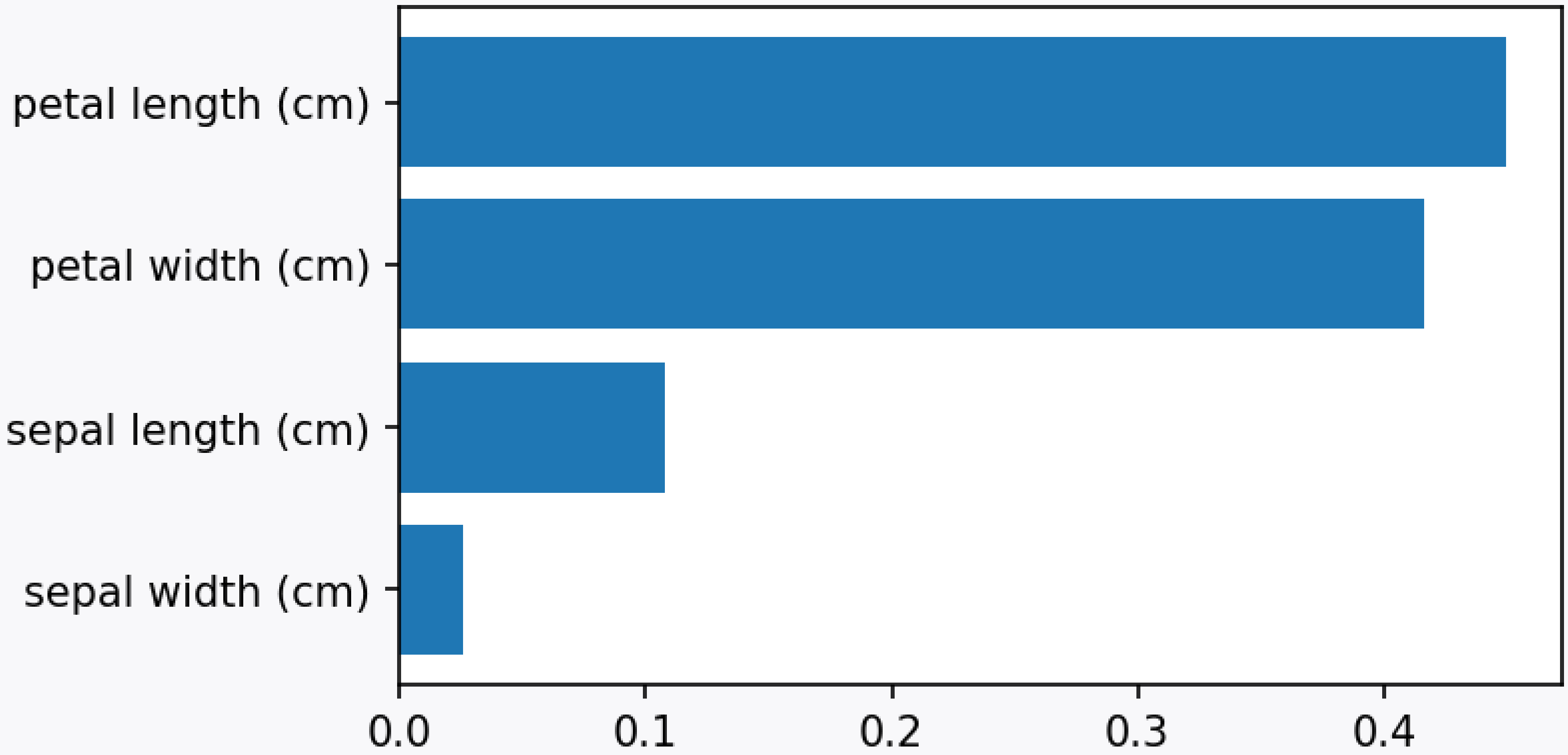
```
for name, score in zip(iris.feature_names, rnd_clf.feature_importances_):
    print(name, score)
```

```
sepal length (cm) 0.08955824422368722
sepal width (cm) 0.02154267813628801
petal length (cm) 0.445423343359405
petal width (cm) 0.4434757342840840
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Feature importance visualization

```
sorted_idx = rnd_clf.feature_importances_.argsort()
plt.figure(figsize=(5,3), dpi=150)
plt.barh(np.asarray(iris.feature_names)[sorted_idx],
         rnd_clf.feature_importances_[sorted_idx])
```



Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Random forests for Cali House Price Pred.

```
from sklearn.datasets import fetch_california_housing
cali_prices = fetch_california_housing()
X_reg = cali_prices.data
y_reg = cali_prices.target
```

```
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error
```

```
X_train,X_test,y_train,y_test = train_test_split(X_reg,y_reg,test_size = 0.01)
for_reg = RandomForestRegressor()
for_reg.fit(X_train, y_train)
```

```
y_pred_train = for_reg.predict(X_train)
y_pred_test = for_reg.predict(X_test)
print(mean_squared_error(y_pred_train, y_train))
print(mean_squared_error(y_pred_test, y_test))
```

```
0.0345495422042868
0.3383040535545396
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Random forests for MNIST classification

```
from keras.datasets import mnist
from sklearn.model_selection import train_test_split

(X_train, y_train), (X_test, y_test) = mnist.load_data()
X_train, X_test = X_train / 255., X_test / 255.
```

```
X_train = X_train.reshape(-1, 28*28)
X_test =  X_test.reshape(-1, 28*28)
```

```
from sklearn.ensemble import RandomForestClassifier
```

```
rnd_clf = RandomForestClassifier(n_estimators=500,
                                 max_leaf_nodes=16,
                                 n_jobs=-1)
rnd_clf.fit(X_train, y_train)
y_pred = rnd_clf.predict(X_test)
print(rnd_clf.score(X_test,y_test))
```

```
0.8298
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Feature importance visualization

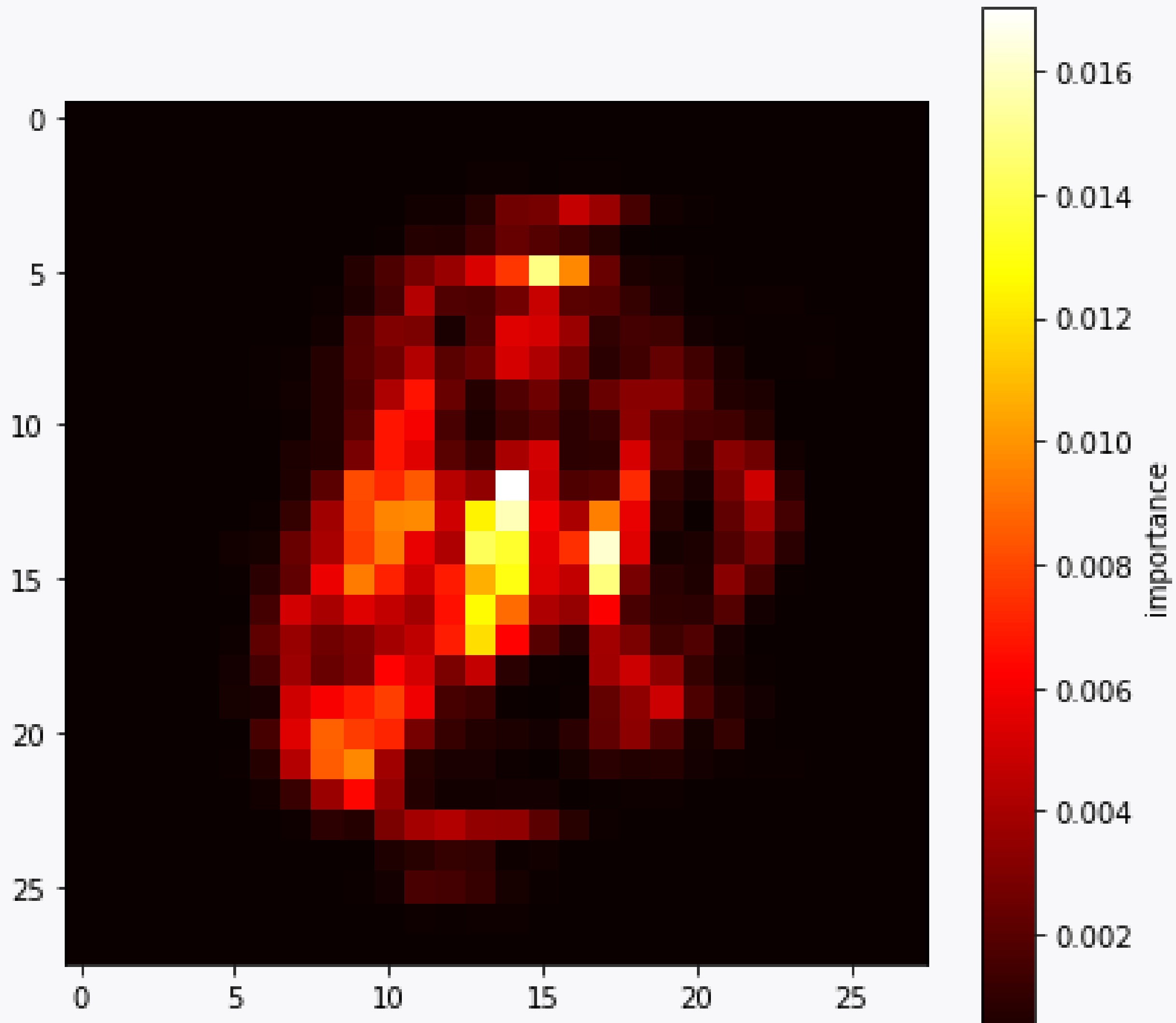
```
import matplotlib.pyplot as plt

feature_importances = rnd_clf.feature_importances_
feature_importances = feature_importances.reshape(28, 28)

plt.imshow(feature_importances, cmap='hot')
```

hot colormap

```
plt.colorbar(label='importance')
plt.show()
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Feature importance visualization



Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Hyperparameter search: GridSearchCV

```
from sklearn.datasets import load_iris
from sklearn.model_selection import train_test_split

Iris = load_iris()
X = Iris.data
y = Iris.target
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.2)

from sklearn.model_selection import GridSearchCV

param_grid = {'n_estimators': [3,10,100,500],
              'max_features': [0.25, 0.5, 0.75, 1]}

forest_clf = RandomForestClassifier(max_depth=2)
grid_search = GridSearchCV(forest_clf,param_grid,cv=5,scoring='accuracy')

grid_search.fit(X_train, y_train)
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Hyperparameter search: GridSearchCV

```
print(grid_search.best_params_)
```

```
{'max_features': 0.75, 'n_estimators': 10}
```

```
print(grid_search.best_estimator_)
```

```
RandomForestClassifier(max_depth=2, max_features=0.75, n_estimators=10)
```

```
print(grid_search.best_score_)
```

```
0.9666666666666666
```

```
feature_importances = grid_search.best_estimator_.feature_importances_
print(feature_importances)
```

```
[0.         0.         0.31446851 0.68553149]
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

Hyperparameter search: GridSearchCV

```
from sklearn.metrics import accuracy_score
```

```
y_pred = grid_search.best_estimator_.predict(X_test)
```

```
print(accuracy_score(y_pred, y_test))
```

```
0.9333333333333333
```

```
print(grid_search.best_estimator_.score(X_test,y_test))
```

```
0.9333333333333333
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

RandomizedSearchCV

```
from sklearn.model_selection import RandomizedSearchCV

param_distributions = {'n_estimators': range(500),
                       'max_features': range(1, 5)}

forest_clf = RandomForestClassifier(max_depth=2)

randomized_search = RandomizedSearchCV(forest_clf,
                                       param_distributions,
                                       cv=4, n_iter = 50,
                                       scoring='accuracy')

randomized_search.fit(X_train, y_train)
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

RandomizedSearchCV

```
print(randomized_search.best_params_)
```

```
{'n_estimators': 419, 'max_features': 2}
```

```
print(randomized_search.best_estimator_)
```

```
RandomForestClassifier(max_depth=2, max_features=2, n_estimators=419)
```

```
print(randomized_search.best_score_)
```

```
0.9333333333333333
```

```
feature_importances = randomized_search.best_estimator_.feature_importances_
print(feature_importances)
```

```
[0.10610445 0.018726   0.41529867 0.45987088]
```

Copyright © 2024 Changho Suh @ KAIST. All rights reserved.

RandomizedSearchCV

```
y_pred = randomized_search.best_estimator_.predict(X_test)
```

```
print(accuracy_score(y_pred, y_test))
```

```
0.9666666666666667
```

```
print(randomized_search.best_estimator_.score(X_test,y_test))
```

```
0.9666666666666667
```