PS14

January 24, 2023

1 Decision tree regressor

1.1 Load California Housing dataset

[1]:
```
from sklearn.datasets import fetch_california_housing
```

[2]:
```
cali_prices = fetch_california_housing()
X_reg = cali_prices.data
y_reg = cali_prices.target

print(X_reg.shape)
print(y_reg.shape)
```

```
(20640, 8)
(20640,)
```

[3]:
```
print(cali_prices.feature_names)
```

```
['MedInc', 'HouseAge', 'AveRooms', 'AveBedrms', 'Population', 'AveOccup',
'Latitude', 'Longitude']
```

[4]:
```
print(X_reg[0])
```

```
[   8.3252       41.            6.98412698    1.02380952  322.
    2.55555556   37.88       -122.23      ]
```

[5]:
```
print(y_reg)
```

```
[4.526 3.585 3.521 … 0.923 0.847 0.894]
```

[6]:
```
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeRegressor
```

[7]:
```
# train-test data split
X_train,X_test,y_train,y_test = train_test_split(X_reg,y_reg,test_size=0.01)

tree_reg = DecisionTreeRegressor(max_depth=4)
# training
```

```
tree_reg.fit(X_train, y_train)

# evaluation (R2 score)
test_performance = tree_reg.score(X_test,y_test)
print(test_performance)
```

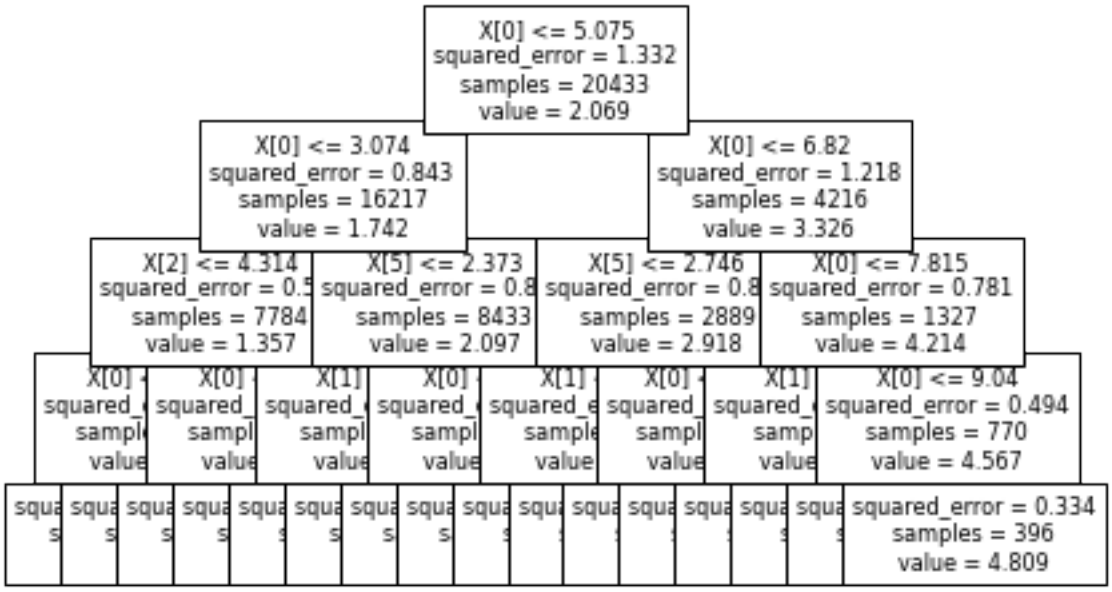
```
0.586918467046906
```

[8]:
```
from sklearn.tree import plot_tree


plot_tree(tree_reg, fontsize=8)
#plot_tree.figure(figsize=(4, 4), dpi=150)
```

[8]:
```
[Text(0.5, 0.9, 'X[0] <= 5.075\nsquared_error = 1.332\nsamples = 20433\nvalue =
2.069'),
 Text(0.25, 0.7, 'X[0] <= 3.074\nsquared_error = 0.843\nsamples = 16217\nvalue =
1.742'),
 Text(0.125, 0.5, 'X[2] <= 4.314\nsquared_error = 0.563\nsamples = 7784\nvalue =
1.357'),
 Text(0.0625, 0.3, 'X[0] <= 2.215\nsquared_error = 0.673\nsamples = 3282\nvalue
= 1.622'),
 Text(0.03125, 0.1, 'squared_error = 0.573\nsamples = 1731\nvalue = 1.374'),
 Text(0.09375, 0.1, 'squared_error = 0.638\nsamples = 1551\nvalue = 1.899'),
 Text(0.1875, 0.3, 'X[0] <= 2.414\nsquared_error = 0.395\nsamples = 4502\nvalue
= 1.164'),
 Text(0.15625, 0.1, 'squared_error = 0.284\nsamples = 2263\nvalue = 0.966'),
 Text(0.21875, 0.1, 'squared_error = 0.428\nsamples = 2239\nvalue = 1.364'),
 Text(0.375, 0.5, 'X[5] <= 2.373\nsquared_error = 0.839\nsamples = 8433\nvalue =
2.097'),
 Text(0.3125, 0.3, 'X[1] <= 19.5\nsquared_error = 1.294\nsamples = 1958\nvalue =
2.803'),
 Text(0.28125, 0.1, 'squared_error = 0.706\nsamples = 539\nvalue = 2.148'),
 Text(0.34375, 0.1, 'squared_error = 1.293\nsamples = 1419\nvalue = 3.052'),
 Text(0.4375, 0.3, 'X[0] <= 4.071\nsquared_error = 0.505\nsamples = 6475\nvalue
= 1.884'),
 Text(0.40625, 0.1, 'squared_error = 0.434\nsamples = 3736\nvalue = 1.713'),
 Text(0.46875, 0.1, 'squared_error = 0.508\nsamples = 2739\nvalue = 2.117'),
 Text(0.75, 0.7, 'X[0] <= 6.82\nsquared_error = 1.218\nsamples = 4216\nvalue =
3.326'),
 Text(0.625, 0.5, 'X[5] <= 2.746\nsquared_error = 0.891\nsamples = 2889\nvalue =
2.918'),
 Text(0.5625, 0.3, 'X[1] <= 19.5\nsquared_error = 0.997\nsamples = 1193\nvalue =
3.407'),
 Text(0.53125, 0.1, 'squared_error = 0.867\nsamples = 329\nvalue = 2.9'),
 Text(0.59375, 0.1, 'squared_error = 0.912\nsamples = 864\nvalue = 3.6'),
 Text(0.6875, 0.3, 'X[0] <= 5.739\nsquared_error = 0.53\nsamples = 1696\nvalue =
```

```
2.575'),
 Text(0.65625, 0.1, 'squared_error = 0.415\nsamples = 877\nvalue = 2.314'),
 Text(0.71875, 0.1, 'squared_error = 0.502\nsamples = 819\nvalue = 2.855'),
 Text(0.875, 0.5, 'X[0] <= 7.815\nsquared_error = 0.781\nsamples = 1327\nvalue =
4.214'),
 Text(0.8125, 0.3, 'X[1] <= 26.5\nsquared_error = 0.767\nsamples = 557\nvalue =
3.725'),
 Text(0.78125, 0.1, 'squared_error = 0.562\nsamples = 336\nvalue = 3.414'),
 Text(0.84375, 0.1, 'squared_error = 0.705\nsamples = 221\nvalue = 4.199'),
 Text(0.9375, 0.3, 'X[0] <= 9.04\nsquared_error = 0.494\nsamples = 770\nvalue =
4.567'),
 Text(0.90625, 0.1, 'squared_error = 0.536\nsamples = 374\nvalue = 4.311'),
 Text(0.96875, 0.1, 'squared_error = 0.334\nsamples = 396\nvalue = 4.809')]
```



[9]:
```
feature_importances_cali = tree_reg.feature_importances_
print(feature_importances_cali)
```

```
[0.83170096 0.03261671 0.02510698 0.         0.         0.11057535
 0.         0.        ]
```

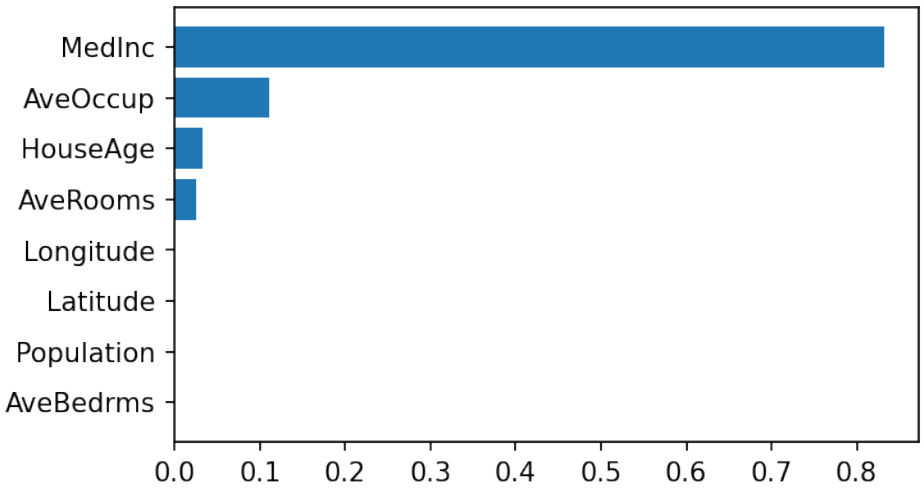
[10]:
```
import matplotlib.pyplot as plt
import numpy as np


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

```
        feature_importances_cali[sorted_idx])


#sorted_idx = tree_reg.feature_importances_.argsort()[::-1]
#plt.barh(np.asarray(cali_prices.feature_names)[sorted_idx][::-1],
#         feature_importances_cali[sorted_idx][::-1])
```

[10]: <BarContainer object of 8 artists>



1.2 MSE performance

[11]:
```
from sklearn.metrics import mean_squared_error
```

[12]:
```
y_pred_train = tree_reg.predict(X_train)
y_pred_test = tree_reg.predict(X_test)
#mse_train = np.mean((y_pred_train - y_train) ** 2)
mse_train = mean_squared_error(y_pred_train, y_train)
mse_test = mean_squared_error(y_pred_test, y_test)
print(mse_train)
print(mse_test)
```

```
0.5548722950891893
0.540480304448986
```

1.3 Comparison with random guess performance

[13]:
```
random_guess_train = np.random.normal(
                     loc = np.mean(y_train),
                     scale = np.std(y_train),
```

```
                    size =  y_train.shape[0])
random_guess_test = np.random.normal(
                    loc = np.mean(y_test),
                    scale = np.std(y_test),
                    size = y_test.shape[0])
mse_first_train = mean_squared_error(random_guess_train, y_train)
mse_first_test = mean_squared_error(random_guess_test, y_test)
print(mse_first_train)
print(mse_first_test)
```

```
2.6748549070685073
2.67179587025698
```

[ ]: