Task 3 - hw2

November 12, 2017

In [7]:
```
from sklearn.base import BaseEstimator
from sklearn import datasets
from sklearn.tree import DecisionTreeRegressor
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

In [12]:
```
class DecisionTree(BaseEstimator):

    class Splitter:
        def H(self, Q):
            return Q.std() ** 2

        def __init__(self, X_data, y_data):
            n = X_data.shape[0]
            best_split_val = None
            best_split_ind = (None, None)
            self.best_split = (0, 0)
#             print(X_data.shape)
            #  ,
            for i in range(X_data.shape[1]):
                indices = np.argsort(X_data[:, i])
                for j in range(1, X_data.shape[0]):
                    cur_split_val = j / n * self.H(y_data[indices[:j]]) + \
                                (n - j) / n * self.H(y_data[indices[j:]])
#                     print (cur_split_val)
                    if best_split_val is None or cur_split_val < best_split_val:
                        best_split_val = cur_split_val
                        best_split_ind = (indices[:j], indices[j:])
                        self.best_split = (i, X_data[indices[j]][i])
            self.l_d, self.r_d = X_data[best_split_ind[0]], X_data[best_split_ind[1]]
            self.l_t, self.r_t = y_data[best_split_ind[0]], y_data[best_split_ind[1]]
#             print(self.best_split)

        def get_best_split_parts(self):
            return self.l_d, self.r_d, self.l_t, self.r_t

        def get_best_split(self):
```

```
                return self.best_split

        def __init__(self, max_depth=5):
            self.max_depth=max_depth
            self.size = 2**(max_depth + 1) - 1
            self.is_leaf = [True] * self.size
            self.splitters = [[] for i in range(self.size)]
            self.data = [[] for i in range(self.size)]
            self.target = [[] for i in range(self.size)]

        def fit(self, X_data, y_data):
            X_data = np.array(X_data)
            y_data = np.array(y_data)
            self.data[0] = X_data
            self.target[0] = y_data
#           print(self.data)
            for i in range(self.size):
                if len(self.target[i]) > 1:
                    self.splitters[i] = self.Splitter(self.data[i], self.target[i])
                    left_d, right_d, left_t, right_t = self.splitters[i].get_best_split_par
                    if 2 * i + 1 < self.size:
                        self.is_leaf[i] = False
                        self.data[2 * i + 1] = left_d
                        self.target[2 * i + 1] = left_t
                        self.data[2 * i + 2] = right_d
                        self.target[2 * i + 2] = right_t
                    else:
                        break


        def predict(self, X_data):
            X_data = np.array(X_data)
            y_predict = np.zeros(X_data.shape[0])
            for i in range(X_data.shape[0]):
                cur_v = 0
                while True:
                    if self.is_leaf[cur_v]:
                        y_predict[i] = self.target[cur_v].mean()
                        break

                    cur_best_split = self.splitters[cur_v].get_best_split()
                    if X_data[i][cur_best_split[0]] < cur_best_split[1]:
                        cur_v = 2 * cur_v + 1
                    else:
                        cur_v = 2 * cur_v + 2
            return y_predict
```

In [15]:
```
data = datasets.load_boston()
```

```
X_train = data.data[:376]
y_train = data.target[:376]
X_test = data.data[376:]
y_test = data.target[376:]
```

```
In [19]: def test_DT(max_depth):
             print("------------------------\nMAX DEPTH=", max_depth)
             my_cl = DecisionTree(max_depth=max_depth)
             my_cl.fit(X_train, y_train)
             my_predict = my_cl.predict(X_test)
             s1 = (my_predict - y_test).std()
             print("RMSE with my Decision Tree:", s1)

             sk_cl = DecisionTreeRegressor(max_depth=6)
             sk_cl.fit(X_train, y_train)
             sk_predict = sk_cl.predict(X_test)
             s2 = (sk_predict - y_test).std()
             print("RMSE with sklearn Decision Tree:", s2)

             sk_cl = DecisionTreeRegressor(max_depth=6, max_features=1)
             sk_cl.fit(X_train, y_train)
             sk_predict = sk_cl.predict(X_test)
             s3 = (sk_predict - y_test).std()
             print("RMSE with sklearn Decision Tree, max_features=1:", s3)

             return s1, s2, s3
```

```
In [22]: my_rmse = []
         sk1_rmse = []
         sk2_rmse = []
         for max_depth in range(1, 8):
             rmses = test_DT(max_depth)

             my_rmse.append(rmses[0])
             sk1_rmse.append(rmses[1])
             sk2_rmse.append(rmses[2])
```

```
------------------------
MAX DEPTH= 1
RMSE with my Decision Tree: 6.29848817251
RMSE with sklearn Decision Tree: 4.34509511709
RMSE with sklearn Decision Tree, max_features=1: 4.68352741884
------------------------
MAX DEPTH= 2
RMSE with my Decision Tree: 5.94429556055
RMSE with sklearn Decision Tree: 4.29884165443
RMSE with sklearn Decision Tree, max_features=1: 4.71168022712
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```

```
MAX DEPTH= 3
RMSE with my Decision Tree: 5.55656533842
RMSE with sklearn Decision Tree: 4.2428296448
RMSE with sklearn Decision Tree, max_features=1: 9.41132039243
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MAX DEPTH= 4
RMSE with my Decision Tree: 5.46603208182
RMSE with sklearn Decision Tree: 4.33993763451
RMSE with sklearn Decision Tree, max_features=1: 7.39442393825
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MAX DEPTH= 5
RMSE with my Decision Tree: 4.90243844642
RMSE with sklearn Decision Tree: 4.33993763451
RMSE with sklearn Decision Tree, max_features=1: 6.32873705357
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MAX DEPTH= 6
RMSE with my Decision Tree: 4.46873329448
RMSE with sklearn Decision Tree: 4.42189805762
RMSE with sklearn Decision Tree, max_features=1: 6.4113508423
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MAX DEPTH= 7
RMSE with my Decision Tree: 4.53680430043
RMSE with sklearn Decision Tree: 4.2428296448
RMSE with sklearn Decision Tree, max_features=1: 13.198621779
```
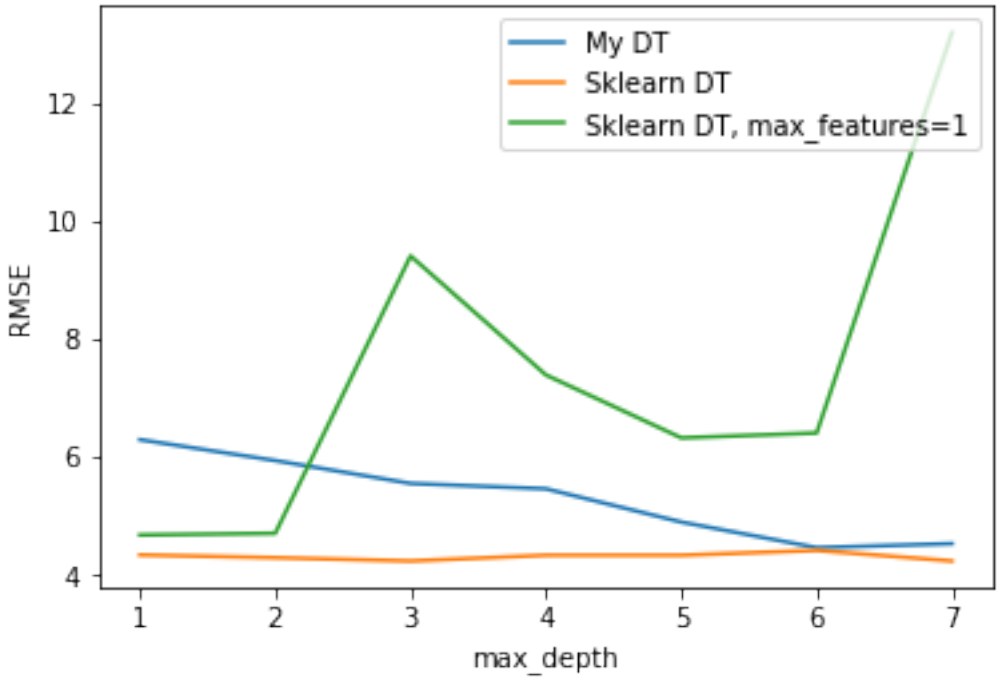

```
In [23]: plt.plot(range(1, 8), my_rmse, label='My DT')
         plt.plot(range(1, 8), sk1_rmse, label='Sklearn DT')
         plt.plot(range(1, 8), sk2_rmse, label='Sklearn DT, max_features=1')
         plt.xlabel('max_depth')
         plt.ylabel('RMSE')
         plt.legend(loc='upper right')
         plt.show()
```


My DT
Sklearn DT
Sklearn DT, max_features=1
RMSE
12
10
8
6
4
1
2
3
4
5
6
7
max_depth