```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline

sns.set()

df =
pd.read_csv('https://raw.githubusercontent.com/arnob016/PyClass/master
/AI%20Lab%20Report/data.csv')
df.head()
```

	R&D Spend	Administration	Marketing Spend	State	Profit
0	165349.20	136897.80	471784.10	New York	192261.83
1	162597.70	151377.59	443898.53	California	191792.06
2	153441.51	101145.55	407934.54	Florida	191050.39
3	144372.41	118671.85	383199.62	New York	182901.99
4	142107.34	91391.77	366168.42	Florida	166187.94

```
df['Profit'] = df['R&D Spend'] + df['Administration'] + df['Marketing
Spend']
df.head()
```

	R&D Spend	Administration	Marketing Spend	State	Profit
0	165349.20	136897.80	471784.10	New York	774031.10
1	162597.70	151377.59	443898.53	California	757873.82
2	153441.51	101145.55	407934.54	Florida	662521.60
3	144372.41	118671.85	383199.62	New York	646243.88
4	142107.34	91391.77	366168.42	Florida	599667.53

```
from sklearn.tree import DecisionTreeRegressor

X = df[['R&D Spend']]
y = df['Profit']

train1 = DecisionTreeRegressor(max_depth=2, random_state=1)

train1.fit(X, y)

DecisionTreeRegressor(max_depth=2, random_state=1)

sns.scatterplot(x=df['R&D Spend'],
                y=df['Profit'],
                label='data')

plt.plot(df['R&D Spend'].sort_values(),
         train1.predict(df['R&D Spend'].sort_values().to_frame()),
```

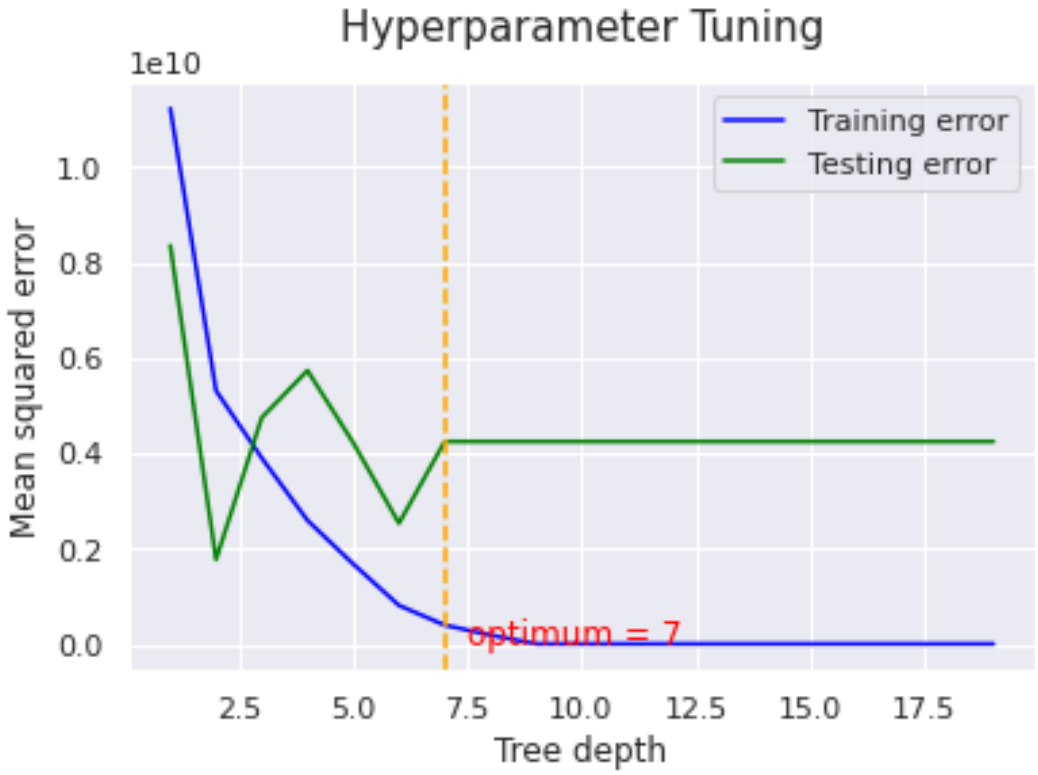
```
          color='Green', label='model',
          linewidth=2)

plt.legend()

plt.savefig('tree1.png')
```


```
from sklearn.tree import export_graphviz
import graphviz

dot_data = export_graphviz(train1, feature_names=['R&D Spend'],
filled=True, rounded=True)

graph = graphviz.Source(dot_data)
graph.render("tree")
```

```
{"type":"string"}
```

```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.10, random_state=0, shuffle=True)

from sklearn.metrics import mean_squared_error as mse

max_depths = range(1, 20)
training_error = []
```

```
for max_depth in max_depths:
    model_1 = DecisionTreeRegressor(max_depth=max_depth)
    model_1.fit(X, y)
    training_error.append(mse(y, model_1.predict(X)))

testing_error = []
for max_depth in max_depths:
    model_2 = DecisionTreeRegressor(max_depth=max_depth)
    model_2.fit(X_train, y_train)
    testing_error.append(mse(y_test, model_2.predict(X_test)))

plt.plot(max_depths, training_error, color='blue', label='Training
error')
plt.plot(max_depths, testing_error, color='green', label='Testing
error')
plt.xlabel('Tree depth')
plt.axvline(x=7, color='orange', linestyle='--')
plt.annotate('optimum = 7', xy=(7.5, 1.17), color='red')
plt.ylabel('Mean squared error')
plt.title('Hyperparameter Tuning', pad=15, size=15)
plt.legend()
plt.savefig('error.png')
```

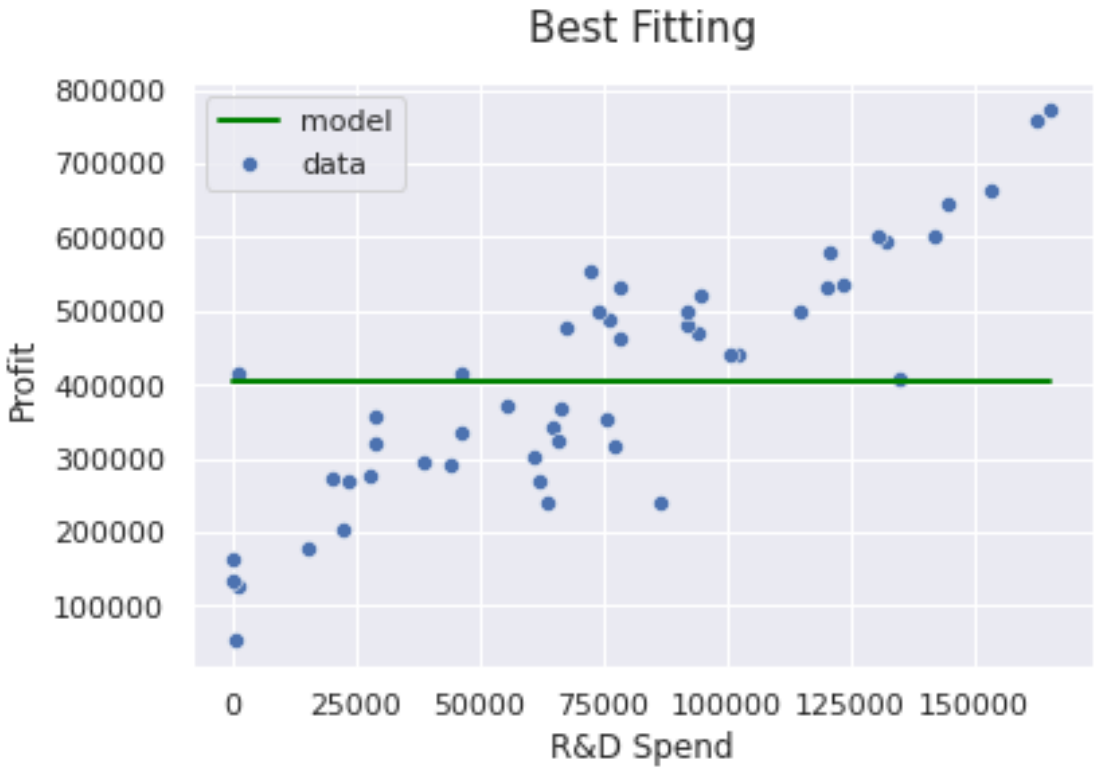



```
from sklearn.model_selection import GridSearchCV

model = DecisionTreeRegressor()
```

```
gs = GridSearchCV(model,
                  param_grid = {'max_depth': range(1, 11),
'min_samples_split': range(10, 60, 10)}, cv=5,
                  n_jobs=1, scoring='neg_mean_squared_error')

gs.fit(X_train, y_train)

print(gs.best_params_)
print(-gs.best_score_)
```

```
{'max_depth': 4, 'min_samples_split': 10}
9604135398.303028
```

```
sns.scatterplot(x=df['R&D Spend'],
                y=df['Profit'],
                label='data')

new_model = DecisionTreeRegressor(max_depth=9,
                                  min_samples_split=50)

new_model.fit(X_train, y_train)

plt.plot(df['R&D Spend'].sort_values(),
         new_model.predict(df['R&D Spend'].sort_values().to_frame()),
         color='green', label='model', linewidth=2)

plt.legend()
plt.title('Best Fitting', pad=15, size=15)
plt.savefig('decisiontree.png')
```


Best Fitting
model
data
Profit
R&D Spend
800000
700000
600000
500000
400000
300000
200000
100000
0
25000
50000
75000
100000
125000
150000