GTB_Example

January 4, 2023

[ ]:

```
import pandas as pd
import numpy as np

from sklearn.metrics import accuracy_score

from sklearn.ensemble import GradientBoostingRegressor

import matplotlib.pyplot as plt
import seaborn as sns
```

Generate the example dataset

[ ]:

```
mean = 5
std = 0.5
n = 100

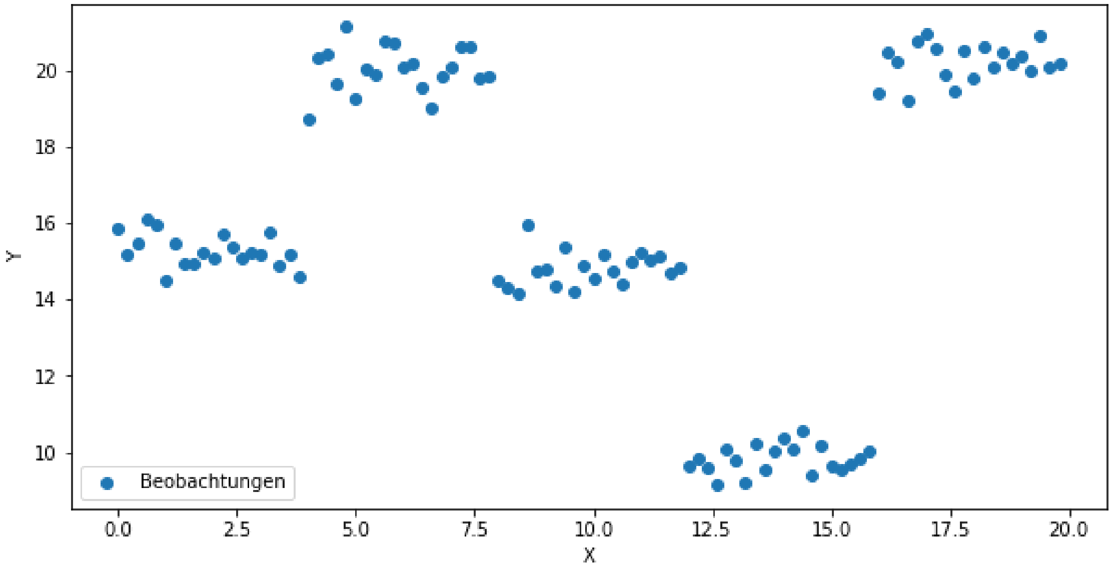
x = []
y = []

np.random.seed(0) # to make random noise reproduceable

for i in range(0,n):
    x.append(i/5)
    # create 5 buckets with noise around different means
    if 0 <= i < 20:
        y.append(10+np.random.normal(mean, std))
    elif 20 <= i < 40:
        y.append(15+np.random.normal(mean, std))
    elif 40 <= i < 60:
        y.append(10+np.random.normal(mean, std))
    elif 60 <= i < 80:
        y.append(5+np.random.normal(mean, std))
    else:
        y.append(15+np.random.normal(mean, std))

plt.figure(figsize=(10,5))
plt.scatter(x=x, y=y, label="Beobachtungen")
plt.legend(loc="lower left")
plt.xlabel("X")
plt.ylabel("Y")
```

```
[ ]: Text(0, 0.5, 'Y')
```



Calculate internal values of GTB for first iterations

```
[ ]: df = pd.DataFrame({"x": x, "y": y})
     df["f0"] = df["y"].mean()
     df["r1"] = df["y"] - df["f0"]
     df["h1"] = np.where(df["x"] <= 15.9, -1.045, 4.181)
     df["f1"] = df["f0"] + df["h1"]
     df.round(2)
```

```
[ ]:        x      y     f0    r1    h1     f1
     0    0.0  15.88  16.03 -0.15 -1.04  14.98
     1    0.2  15.20  16.03 -0.83 -1.04  14.98
     2    0.4  15.49  16.03 -0.54 -1.04  14.98
     3    0.6  16.12  16.03  0.09 -1.04  14.98
     4    0.8  15.93  16.03 -0.10 -1.04  14.98
     ..   …     …    …     …     …     …
     95  19.0  20.35  16.03  4.32  4.18  20.21
     96  19.2  20.01  16.03  3.98  4.18  20.21
     97  19.4  20.89  16.03  4.86  4.18  20.21
     98  19.6  20.06  16.03  4.03  4.18  20.21
     99  19.8  20.20  16.03  4.17  4.18  20.21

     [100 rows x 6 columns]
```

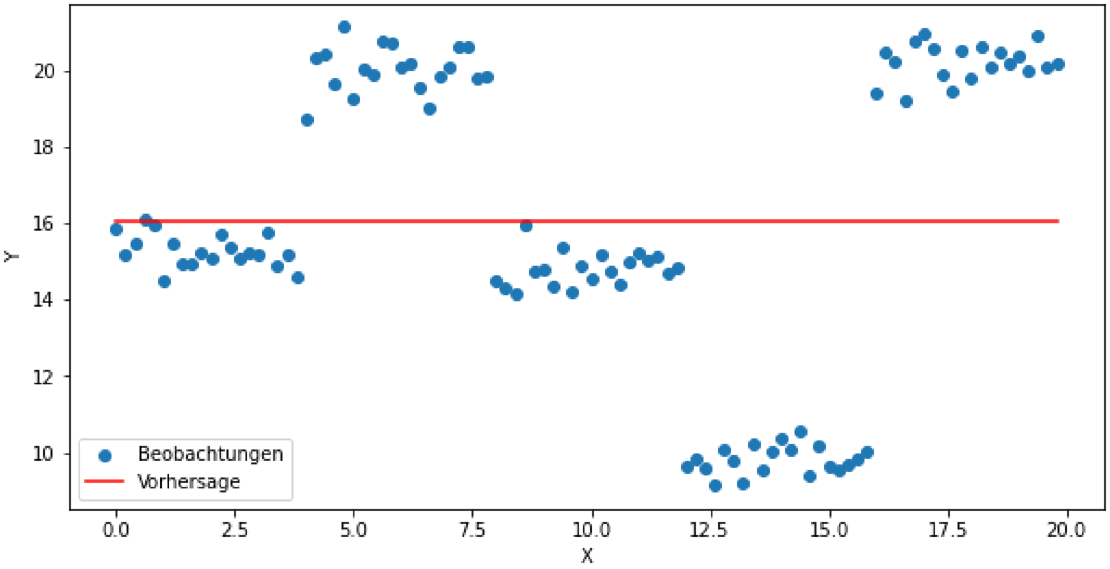
Plot first simple model f_0

[ ]:

```
plt.figure(figsize=(10,5))
plt.scatter(x=x, y=y, label="Beobachtungen")
line_predictions = plt.plot(x, np.full((1,100), df["y"].mean())[0], "-",␣
 ↪color="red", label="Vorhersage")
plt.legend(loc="lower left")
plt.xlabel("X")
plt.ylabel("Y")
```

[ ]:

```
Text(0, 0.5, 'Y')
```



Create the GTB model

[ ]:

```
# reshape data to fit for sklearn GTB Regressor
X_train = np.array(x).reshape(-1, 1)
Y_train = np.array(y)

# train GTB Regressor
model = GradientBoostingRegressor(learning_rate=0.1, max_depth=1,␣
 ↪n_estimators=2)
model.fit(X_train, Y_train)

y_pred = model.predict(X_train) # make predictions
model.score(X_train, Y_train) # return accuracy score
```

[ ]:

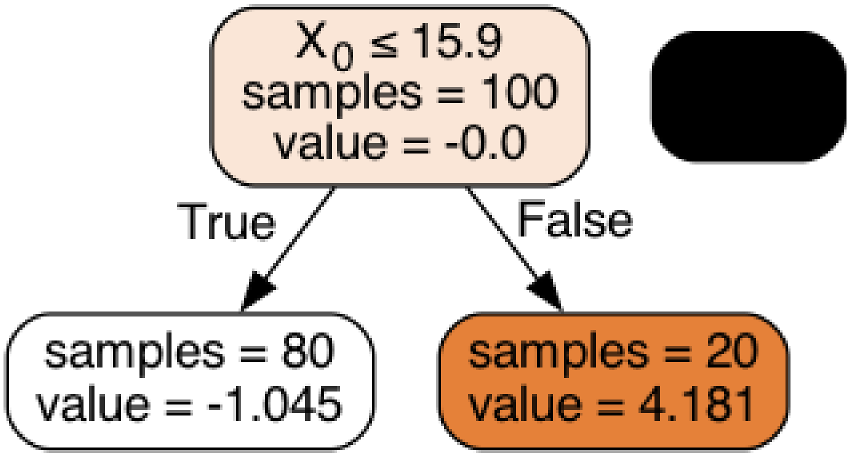
```
0.10002431331091155
```

Visualize the first regression model inside the GTB model

```
[ ]: tree = model.estimators_[0,0] # change first 0 to any number m to get the␣
       ↪regression model m
     from pydotplus import graph_from_dot_data
     from IPython.display import Image
     from sklearn.tree import export_graphviz

     dot_data = export_graphviz(
         tree,
         out_file=None, filled=True, rounded=True,
         special_characters=True,
         proportion=False, impurity=False
     )
     graph = graph_from_dot_data(dot_data)
     Image(graph.create_png())
```

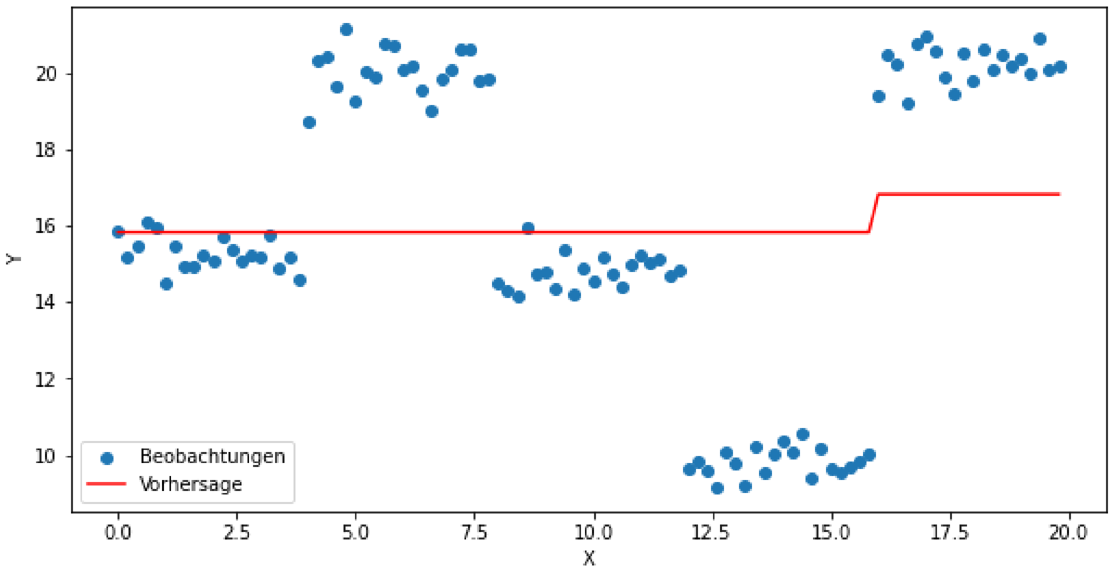
[ ]:



Visualize the current prediction function on dataset

```
[ ]: X_train = X_train.reshape(1,-1)[0] # reshape to fit for visualization
     plt.figure(figsize=(10,5))
     plt.scatter(x=X_train, y=Y_train, label="Beobachtungen")
     line_predictions = plt.plot(X_train, y_pred, "-", color="red",␣
       ↪label="Vorhersage")
     plt.legend(loc="lower left")
     plt.xlabel("X")
     plt.ylabel("Y")
```

```
[ ]: Text(0, 0.5, 'Y')
```



[ ]:
```
y_pred
```

[ ]:
```
array([15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
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       15.83132073, 15.83132073, 15.83132073, 15.83132073, 15.83132073,
       16.82423712, 16.82423712, 16.82423712, 16.82423712, 16.82423712,
       16.82423712, 16.82423712, 16.82423712, 16.82423712, 16.82423712,
       16.82423712, 16.82423712, 16.82423712, 16.82423712, 16.82423712,
       16.82423712, 16.82423712, 16.82423712, 16.82423712, 16.82423712])
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