gb_algorithm

January 31, 2022

[2]:
```
import pandas as pd
import math
from sklearn.tree import DecisionTreeRegressor
import graphviz
from sklearn import tree
```

Dataset:

[3]:
```
d = {'category': ['hiphop', 'hiphop', 'hiphop', 'hiphop', 'hiphop', 'jazz',␣
 ↪'jazz', 'jazz'],
     'track':    ['h1', 'h2', 'h3', 'h4', 'h5', 'j1', 'j2', 'j3'],
     'feature_danceability' : [0.949, 0.743, 0.913, 0.810, 0.434, 0.654, 0.593,␣
 ↪0.234],
     'feature_acousticness' : [0.132, 0.234, 0.394, 0.504, 0.198, 0.534, 0.312,␣
 ↪0.341],
     'label'                : [1, 1, 1, 1, 1, 0, 0, 0]}
df = pd.DataFrame(data=d)

df
```

[3]:

	category	track	feature_danceability	feature_acousticness	label
0	hiphop	h1	0.949	0.132	1
1	hiphop	h2	0.743	0.234	1
2	hiphop	h3	0.913	0.394	1
3	hiphop	h4	0.810	0.504	1
4	hiphop	h5	0.434	0.198	1
5	jazz	j1	0.654	0.534	0
6	jazz	j2	0.593	0.312	0
7	jazz	j3	0.234	0.341	0

Initial Prediction:

[4]:
```
hiphop  = 0
jazz    = 0

for i, row in enumerate(df.values):
    # hiphop
    if row[4] == 1:
```

```
        hiphop  = hiphop + 1
    # jazz
    else:
        jazz    = jazz + 1

# calculate initial predictions

f0x = math.log(hiphop/jazz)

f0x
```

[4]: 0.5108256237659907

[5]:
```
# append initial prediction to dataset (equal for every sample)
f0x_array = []

for i, row in enumerate(df.values):
    f0x_array.append (f0x)

df['f0x'] = f0x_array

df
```

[5]:

	category	track	feature_danceability	feature_acousticness	label	f0x
0	hiphop	h1	0.949	0.132	1	0.510826
1	hiphop	h2	0.743	0.234	1	0.510826
2	hiphop	h3	0.913	0.394	1	0.510826
3	hiphop	h4	0.810	0.504	1	0.510826
4	hiphop	h5	0.434	0.198	1	0.510826
5	jazz	j1	0.654	0.534	0	0.510826
6	jazz	j2	0.593	0.312	0	0.510826
7	jazz	j3	0.234	0.341	0	0.510826

Iterative Process:

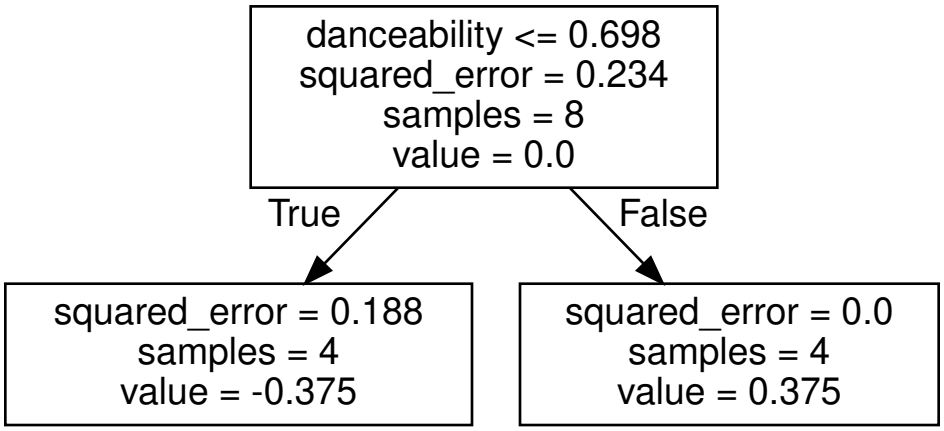
First Iteration:

[6]:
```
# calculate probabilites
prob_array = []
e = 2.718

for i, row in enumerate(df.values):
    prob = math.pow(e, row[5]) / (1 + math.pow(e, row[5]))
    prob_array.append(prob)

df['probability_f0x'] = prob_array
```

[7]:
```
# calculate pseudo residuals
residual_array = []

for i, row in enumerate(df.values):
    residual = row[4] - row[6]
    residual_array.append(residual)

df['pseudo_residuals_1'] = residual_array
```

[8]:
```
# build regression tree

# input values
features = ['feature_danceability']
Y = df['pseudo_residuals_1']
X = df[features]

# build tree
dt = DecisionTreeRegressor(max_depth = 1)
dt.fit(X, Y)

# display
dot_data = tree.export_graphviz(
    dt,
    feature_names = ['danceability']
    )
graph = graphviz.Source(dot_data)

graph
```

[8]:



[9]:
```
# calculate output values

sum_pr    = 0
```

```
sum_prob = 0

# leafs
left = df.loc[df['feature_danceability'] < 0.698]
right = df.loc[df['feature_danceability'] > 0.698]

# left leaf
for i, row in enumerate(left.values):
    sum_pr   = sum_pr + row[7]
    sum_prob = sum_prob + (row[6] * (1 - row[6]))

ov_left = sum_pr / sum_prob

sum_pr   = 0
sum_prob = 0

for i, row in enumerate(right.values):
    sum_pr   = sum_pr + row[7]
    sum_prob = sum_prob + (row[6] * (1 - row[6]))

ov_right = sum_pr / sum_prob

# fill table
ov_array = []

for i, row in enumerate(df.values):
    if row[2] < 0.698:
        ov = ov_left
    else:
        ov = ov_right
    ov_array.append(ov)

print(ov_left)
print(ov_right)

df['output_value_1'] = ov_array
```

```
-1.599925851127446
1.6000317795910484
```

[10]:
```
# new predictions
learning_rate = 0.6

f1x_array = []

for i, row in enumerate(df.values):
    f1x = row[5] + (learning_rate * row[8])
```

```
    f1x_array.append(f1x)

df['f1x'] = f1x_array
```

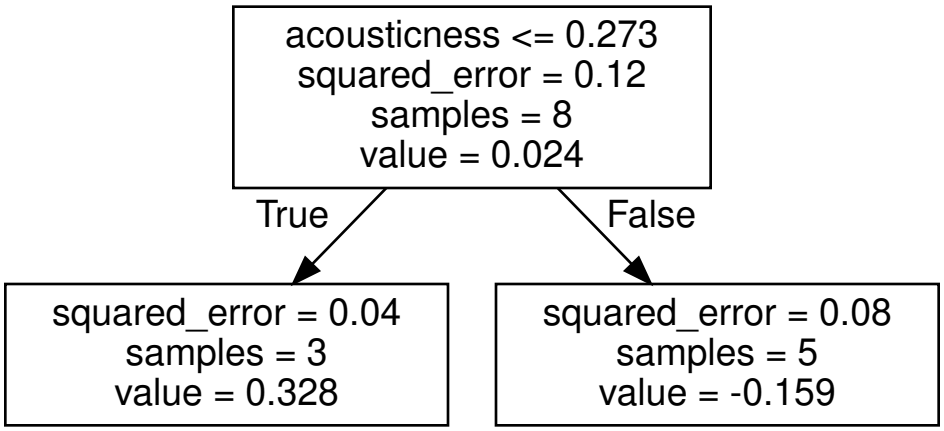
Second Iteration:

[11]:
```
# calculate probabilites
prob_array = []

for i, row in enumerate(df.values):
    prob = math.pow(e, row[9]) / (1 + math.pow(e, row[9]))
    prob_array.append(prob)

df['probability_f1x'] = prob_array
```

[12]:
```
# calculate pseudo residuals
residual_array = []

for i, row in enumerate(df.values):
    residual = row[4] - row[10]
    residual_array.append(residual)

df['pseudo_residuals_2'] = residual_array
```

[13]:
```
# build regression tree

# input values
features = ['feature_acousticness']
Y = df['pseudo_residuals_2']
X = df[features]

# build tree
dt2 = DecisionTreeRegressor(max_depth = 1)
dt2.fit(X, Y)

# display
dot_data = tree.export_graphviz(
    dt2,
    feature_names = ['acousticness']
    )
graph = graphviz.Source(dot_data)

graph
```

[13]:



[14]:
```
# calculate output values

sum_pr   = 0
sum_prob = 0

# leafs
left = df.loc[df['feature_acousticness'] < 0.273]
right = df.loc[df['feature_acousticness'] > 0.273]

# left leaf
for i, row in enumerate(left.values):
    sum_pr   = sum_pr + row[11]
    sum_prob = sum_prob + (row[10] * (1 - row[10]))

ov_left = sum_pr / sum_prob

print(sum_pr)
print(sum_prob)

sum_pr   = 0
sum_prob = 0

for i, row in enumerate(right.values):
    sum_pr   = sum_pr + row[11]
    sum_prob = sum_prob + (row[10] * (1 - row[10]))

ov_right = sum_pr / sum_prob

# fill table
ov_array = []

for i, row in enumerate(df.values):
```

```
    if row[3] < 0.273:
        ov = ov_left
    else:
        ov = ov_right
    ov_array.append(ov)

print(ov_left)
print(ov_right)

df['output_value_2'] = ov_array
```

```
0.9840961179667522
0.5416655512088253
1.8167965745108998
-0.7815561900329465
```

[15]:
```
# new predictions
f2x_array = []

for i, row in enumerate(df.values):
    f2x = row[9] + (learning_rate * row[12])
    f2x_array.append(f2x)

df['f2x'] = f2x_array
```

Final Calculation Predictions for samples

[16]:
```
# calculate probabilites
prob_array = []

for i, row in enumerate(df.values):
    prob = math.pow(e, row[13]) / (1 + math.pow(e, row[13]))
    prob_array.append(prob)

prob_array

df['Final Classification Probability'] = prob_array

df

# probability that song belongs to category hiphop
```

[16]:

	category	track	feature_danceability	feature_acousticness	label	f0x	\
0	hiphop	h1	0.949	0.132	1	0.510826	
1	hiphop	h2	0.743	0.234	1	0.510826	
2	hiphop	h3	0.913	0.394	1	0.510826	
3	hiphop	h4	0.810	0.504	1	0.510826	

```
4   hiphop    h5                0.434                0.198      1  0.510826
5     jazz    j1                0.654                0.534      0  0.510826
6     jazz    j2                0.593                0.312      0  0.510826
7     jazz    j3                0.234                0.341      0  0.510826

   probability_f0x  pseudo_residuals_1  output_value_1       f1x  \
0         0.624988            0.375012        1.600032  1.470845
1         0.624988            0.375012        1.600032  1.470845
2         0.624988            0.375012        1.600032  1.470845
3         0.624988            0.375012        1.600032  1.470845
4         0.624988            0.375012       -1.599926 -0.449130
5         0.624988           -0.624988       -1.599926 -0.449130
6         0.624988           -0.624988       -1.599926 -0.449130
7         0.624988           -0.624988       -1.599926 -0.449130

   probability_f1x  pseudo_residuals_2  output_value_2       f2x  \
0         0.813163            0.186837        1.816797  2.560923
1         0.813163            0.186837        1.816797  2.560923
2         0.813163            0.186837       -0.781556  1.001911
3         0.813163            0.186837       -0.781556  1.001911
4         0.389579            0.610421        1.816797  0.640948
5         0.389579           -0.389579       -0.781556 -0.918064
6         0.389579           -0.389579       -0.781556 -0.918064
7         0.389579           -0.389579       -0.781556 -0.918064

   Final Classification Probability
0                          0.928286
1                          0.928286
2                          0.731414
3                          0.731414
4                          0.654953
5                          0.285372
6                          0.285372
7                          0.285372
```