Exercise 17

June 13, 2022

1 Exercise 17

1.0.1 c)

[1]:

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np

Y = pd.read_csv("soccer.csv")

def log(p):       # help-function to calculate log expression for entropy
    if p == 0:
        return 0
    return p*np.log2(p)

def H_Y(Y, dt):  # calculate entropy of dataset Y on decision target dt
    n = len(Y)
    p = len(Y[Y[dt] == True])/n     # propability of decision target = True
    return -(log(p) + log(1-p))

def H_YX(Y, dt, subspace1, subspace2):  # entropy of Y under condition X,␣
 ↪subspaces: seperation of Y according to X
    n = len(Y)
    n1 = len(subspace1)
    n2 = n - n1

    # propabilities
    p11, p12, p21, p22 = [0,0,0,0]

    if n1 != 0: # avoid devision by 0
        p11 = len(subspace1[subspace1[dt] == True])/n1
        p12 = len(subspace1[subspace1[dt] == False])/n1

    if n2 != 0:
        p21 = len(subspace2[subspace2[dt] == True])/n2
        p22 = len(subspace2[subspace2[dt] == False])/n2

    return -n1/n*(log(p11) + log(p12)) - n2/n*(log(p21) + log(p22))
```

```
# information-gain of cardinal attribute
def IG_cardinal(Y, at, cut, dt):     # at: attribute, dt: decision target, cut: value of cut
    h_y = H_Y(Y, dt)
    n = len(Y)

    # dividing Y in 2 subspaces
    subspace1 = Y[Y[at] <= cut]
    subspace2 = Y[Y[at] > cut]

    h_yx = H_YX(Y, dt, subspace1, subspace2)

    return h_y - h_yx

# information-gain of nominal attribute
def IG_nominal(Y, at, dt, cut):
    h_y = H_Y(Y, dt)
    n = len(Y)

    a = np.zeros(len(Y), dtype = bool)

    for i in range(len(Y)):
        if Y["weather_forecast"][i] in cut:
            a[i] = True

    subspace1 = Y[a]
    subspace2 = Y[a == False]

    h_yx = H_YX(Y, dt, subspace1, subspace2)

    return h_y - h_yx

print(IG_nominal(Y, "weather_forecast", "soccer", ["rainy"]))
print(IG_nominal(Y, "weather_forecast", "soccer", ["cloudy"]))
print(IG_nominal(Y, "weather_forecast", "soccer", ["sunny"]))
```

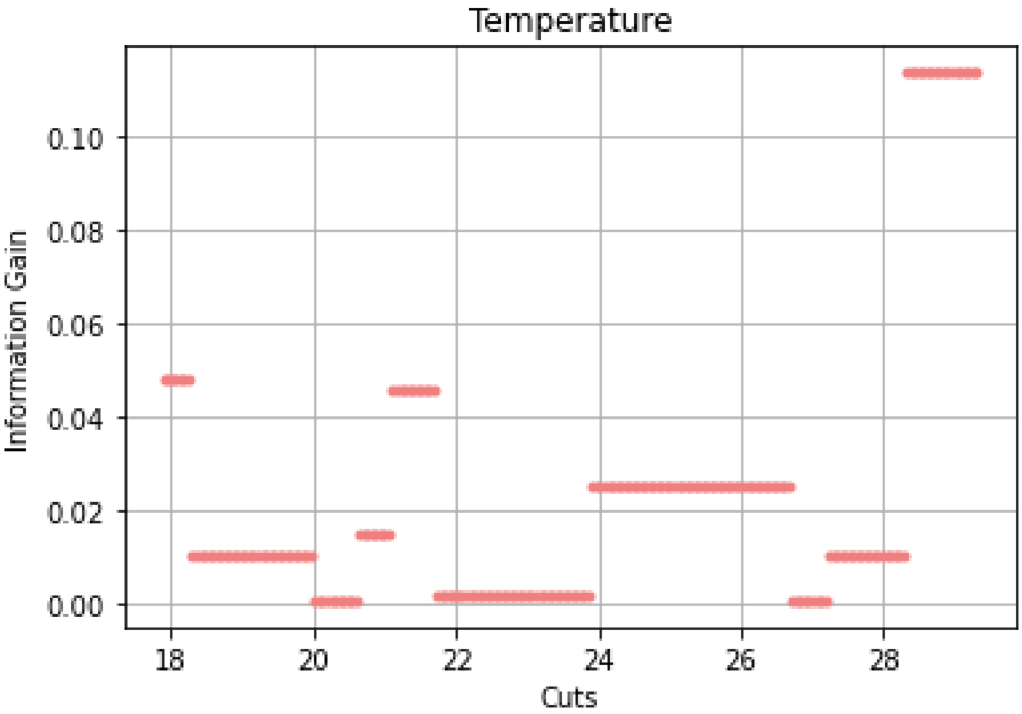
```
0.003184853044648994
0.22600024438491684
0.10224356360985076
```

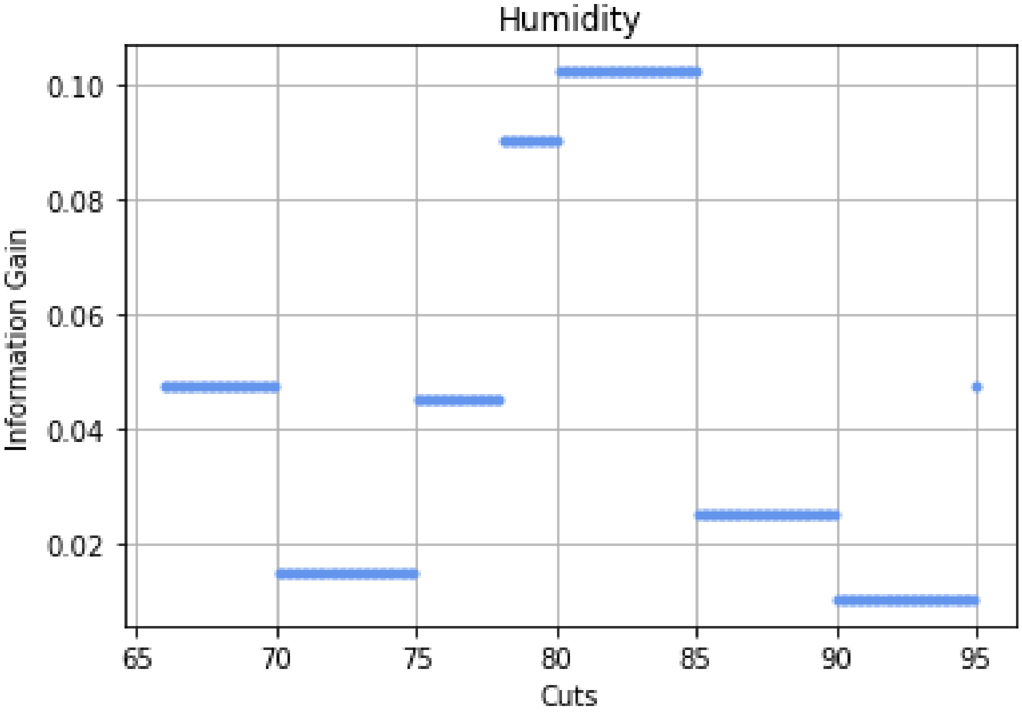
[2]:

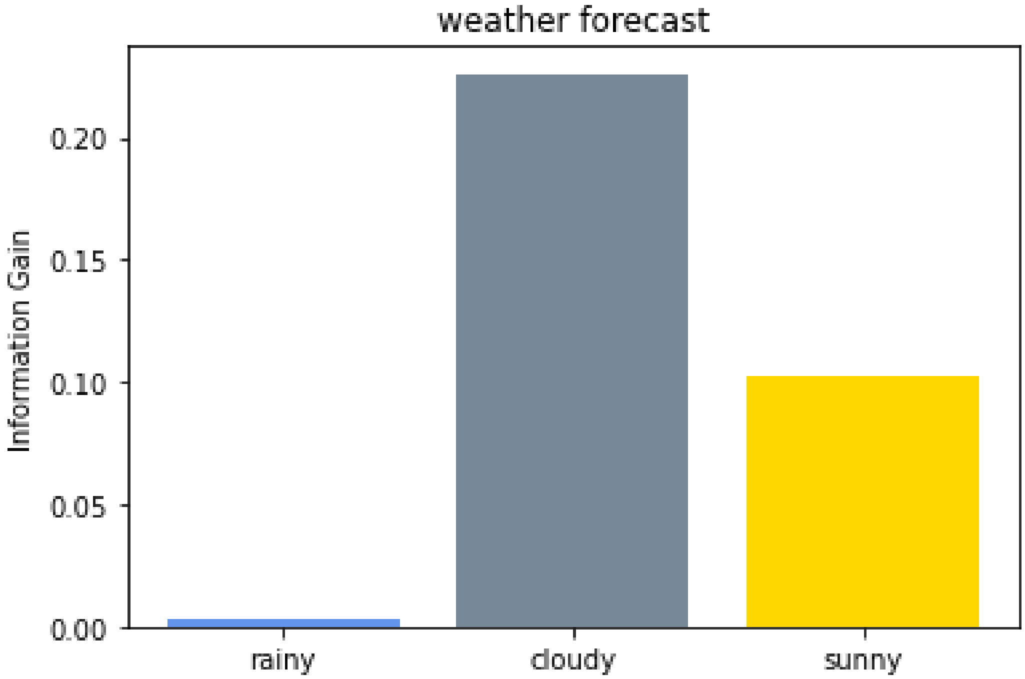
```
# plots

# plot for attribute temperature
fig, axs = plt.subplots()

cuts = np.linspace(17.9, 29.3, 200)
```

```
for i in range(len(cuts)):
    axs.plot(cuts[i], IG_cardinal(Y, "temperature", cuts[i], "soccer"), marker␣
 ↪= ".", color = "lightcoral")

plt.grid()
axs.set_xlabel("Cuts")
axs.set_ylabel("Information Gain")
axs.set_title("Temperature")


# plot for attribute humidity
fig2, axs2 = plt.subplots()

cuts2 = np.linspace(66, 95, 200)

for i in range(len(cuts2)):
    axs2.plot(cuts2[i], IG_cardinal(Y, "humidity", cuts2[i], "soccer"), marker␣
 ↪= ".", color = "cornflowerblue")

plt.grid()
axs2.set_xlabel("Cuts")
axs2.set_ylabel("Information Gain")
axs2.set_title("Humidity")

# plot for weather forecast
fig2, axs2 = plt.subplots()

axs2.bar(1, IG_nominal(Y, "weather_forecast", "soccer", ["rainy"]), color =␣
 ↪"cornflowerblue")
axs2.bar(2, IG_nominal(Y, "weather_forecast", "soccer", ["cloudy"]), color =␣
 ↪"lightslategrey")
axs2.bar(3, IG_nominal(Y, "weather_forecast", "soccer", ["sunny"]), color =␣
 ↪"gold")

axs2.set_xticks([1, 2, 3], ["rainy", "cloudy", "sunny"])
axs2.set_ylabel("Information Gain")
axs2.set_title("weather forecast")
```

```
[2]: Text(0.5, 1.0, 'weather forecast')
```


Temperature
Information Gain
0.00
0.02
0.04
0.06
0.08
0.10
18
20
22
24
26
28
Cuts


Humidity
Information Gain
0.02
0.04
0.06
0.08
0.10
65
70
75
80
85
90
95
Cuts



1.0.2 d)

```
[3]: print(IG_nominal(Y, "weather_forecast", "soccer", ["cloudy"]))
```

```
0.22600024438491684
```

The attribute “weather forecast” is suited best to derive a decision, since the information gain reaches a maximum of 0.23 for a cut between “cloudy” and “sunny”, “rainy” weather conditions. No other attribute reaches a higher information gain for any cut.