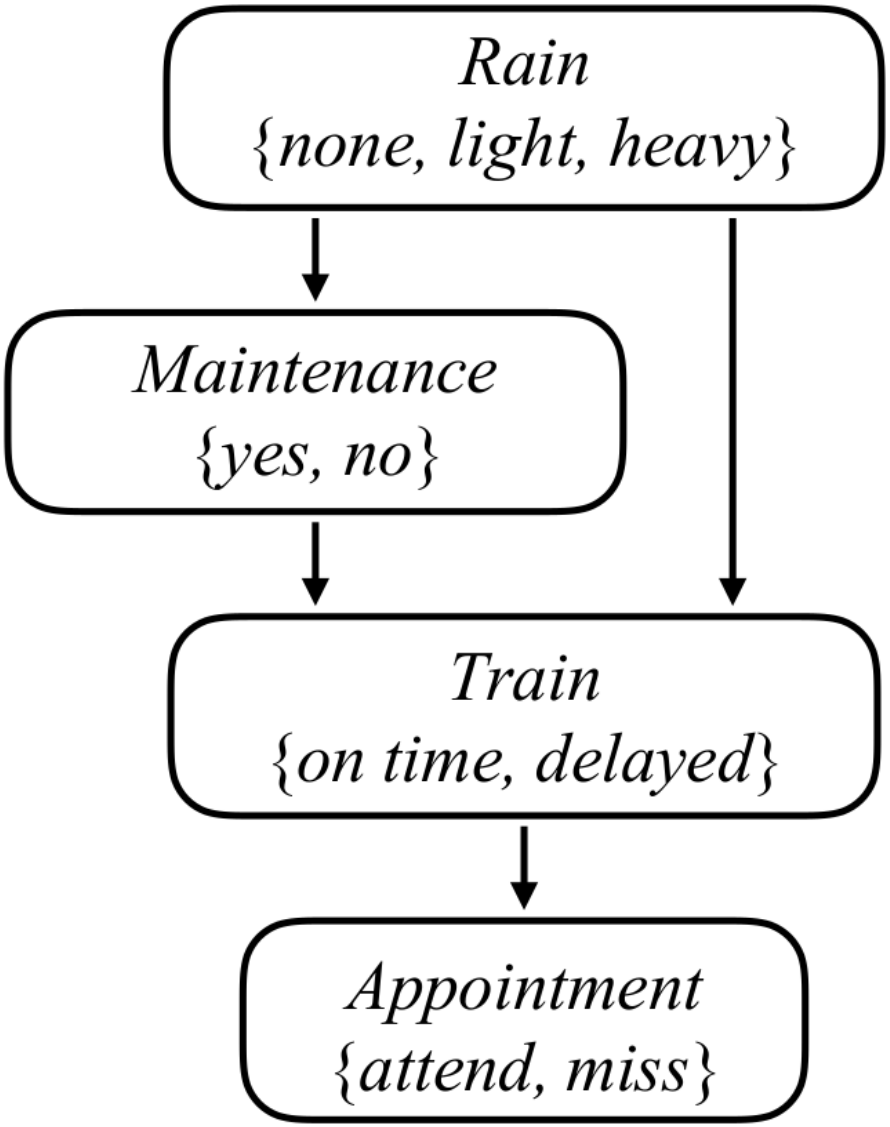
Assignment on Uncertainty

Ayesha Binte Mostofa
1805062

Department of Computer Science and Engineering
Bangladesh University of Engineering and Technology

January 13, 2023

Scenario


Rain
{none, light, heavy}
Maintenance
{yes, no}
Train
{on time, delayed}
Appointment
{attend, miss}

Given Problem

- Given, Train state = delayed. Find updated probability distributions of other variables Rain and Maintenance. You must mathematically derive these probability distributions using the given formula.

Distribution of Rain States

Rain States		
None	Light	Heavy
0.7	0.2	0.1

Distribution of Maintenance States

Maintenance States		
Rain	Yes	No
None	0.4	0.6
Light	0.2	0.8
Heavy	0.1	0.9

Distribution of Train State – Delayed

Train State : Delayed		
Rain	Maintenance	Delayed
None	Yes	0.2
None	No	0.1
Light	Yes	0.4
Light	No	0.3
Heavy	Yes	0.6
Heavy	No	0.5

Probability Calculation of Train States

$$P(None, Yes, Delayed) = P(None)P(Yes|None)P(Delayed|None, Yes)$$

$$= 0.7*0.4*0.2 = 0.056$$

$$P(None, No, Delayed) = P(None)P(No|None)P(Delayed|None, No)$$

$$= 0.7*0.6*0.1 = 0.042$$

Probability Calculation of Train States

$$P(Light, Yes, Delayed) = P(Light)P(Yes|Light)P(Delayed|Light, Yes)$$

$$= 0.2*0.2*0.4 = 0.016$$

$$P(Light, No, Delayed) = P(Light)P(No|Light)P(Delayed|Light, No)$$

$$= 0.2*0.8*0.3 = 0.048$$

Probability Calculation of Train States

$P(Heavy, Yes, Delayed) =$
$P(Heavy)P(Yes|Heavy)P(Delayed|Heavy, Yes)$
$= 0.1*0.1*0.6 = 0.006$

$P(Heavy, No, Delayed) =$
$P(Heavy)P(No|Heavy)P(Delayed|Heavy, No)$
$= 0.1*0.9*0.5 = 0.045$

Probability Distribution of Rain State

Marginalization of Rain States, given that train = delayed

$P(None|delayed) = P(None, Yes|delayed) + P(None, No|delayed)$
$= .056 + .042 = .098$

$P(Light|delayed) = P(Light, Yes|delayed) + P(Light, No|delayed)$
$= .016 + .048 = .064$

$P(Heavy|delayed) = P(Heavy, Yes|delayed) + P(Heavy, No|delayed)$
$= .006 + .045 = .051$

Probability Distribution of Rain States :
P(Rain|train = delayed)
$= \alpha$ <0.098,0.064,0.051>
= <0.46,0.3005,0.2395>

Probability Distribution of Maintenance State

Marginalization of Maintenance States, given that train = delayed

$P(Yes|delayed) =$
$P(Yes, None|delayed) + P(Yes, Light|delayed) + P(Yes, Heavy|delayed)$
$= 0.056 + 0.016 + 0.006 = .078$

$P(No|delayed) =$
$P(No, None|delayed) + P(No, Light|delayed) + P(No, Heavy|delayed) =$
$0.042 + 0.048 + 0.045 = .135$

Probability Distribution of Maintenance States :
P(Maintenance|train = delayed)
$= \alpha$ <.078,.135>
= <0.3662,.6338>

Code

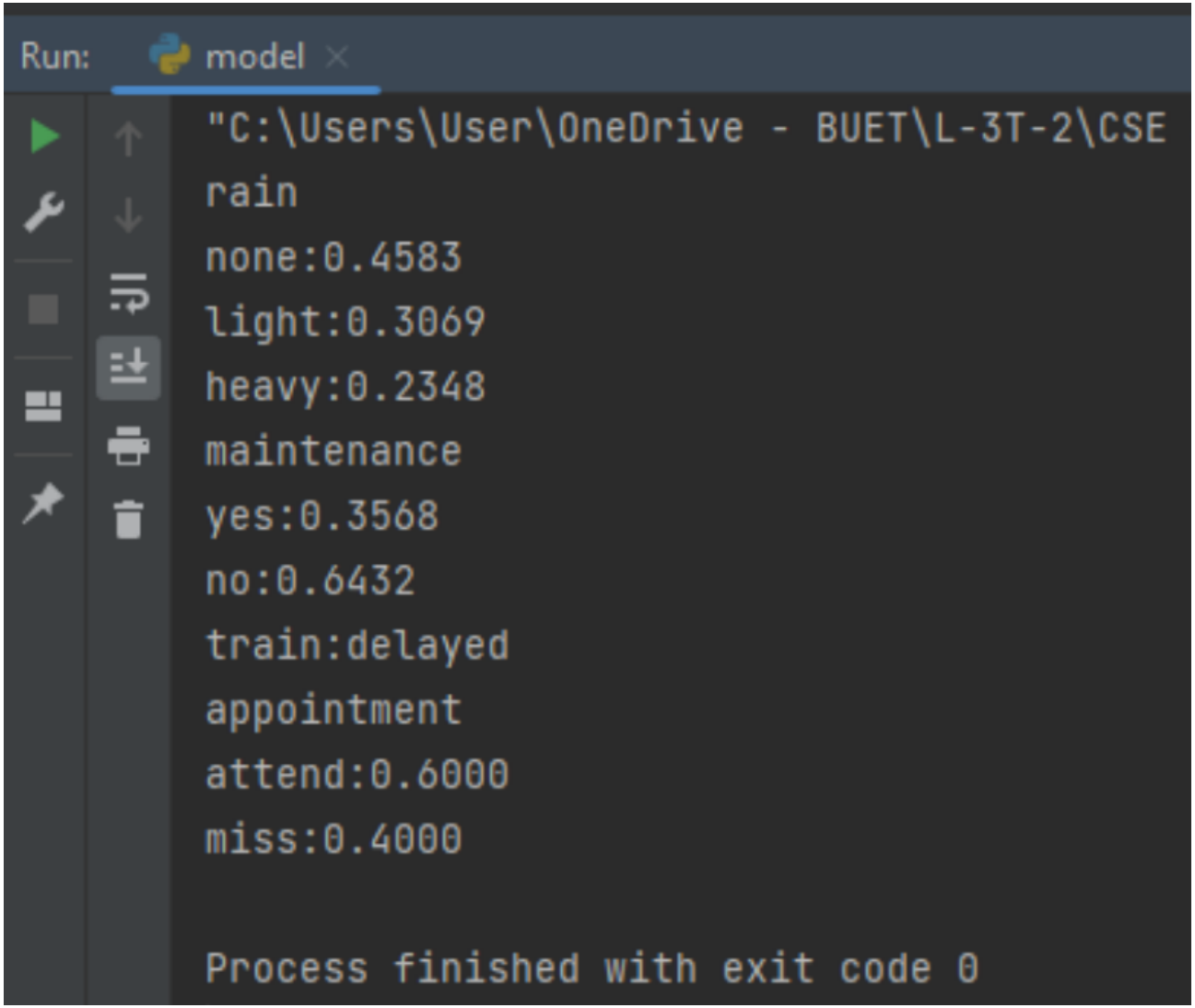
```
# Calculate probability for a given observation
probability = model.probability([["none","no","on time","attend"]])

print(probability)

# Calculate predictions based on the evidence that the train was delayed
predictions = model.predict_proba({
    "train": "delayed"
})

# Print predictions for each node
for node, prediction in zip(model.states,predictions):
    if isinstance(prediction, str):
        # node on which given condition is applied
        print(f"{node.name}:{prediction}")
    else:
        print(f"{node.name}")
        for value,probability in prediction.parameters[0].items():
            print(f"{value}:{probability:.4f}")
```

Result


Run:
model
"C:\Users\User\OneDrive - BUET\L-3T-2\CSE
rain
none:0.4583
light:0.3069
heavy:0.2348
maintenance
yes:0.3568
no:0.6432
train:delayed
appointment
attend:0.6000
miss:0.4000
Process finished with exit code 0