CSE317 Assignment:1

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Bayesian Network

A Bayesian network is a data structure that represents the dependencies among random variables. Bayesian networks have the following properties:

- These are directed graphs.
- Each node on the graph represents a random variable.
- An arrow from X to Y represents that X is a parent of Y. That is, the probability distribution of Y depends on the value of X.
- Each node X has conditional probability distribution $P(X \mid Parents(X))$.

Example of a Bayesian Network

Let's consider an example of a Bayesian network that involves variables that affect whether we get to our appointment on time.

Probability Distribution of Rain

none	light	heavy
0.7	0.2	0.1

Probability Distribution of Maintenance

R	yes	no
none	0.4	0.6
light	0.2	0.8
heavy	0.1	0.9

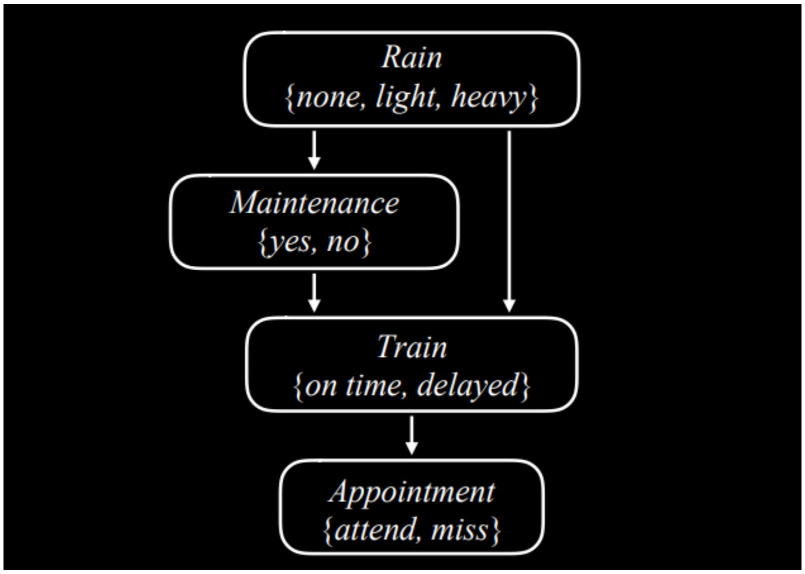


Figure 1: Bayesian Network

Probability Distribution of Train

R	M	on time	delayed
none	yes	0.8	0.2
none	no	0.9	0.1
light	yes	0.6	0.4
light	no	0.7	0.3
heavy	yes	0.4	0.6
heavy	no	0.5	0.5

Probability Distribution of Appointment

T	attend	miss
on time	0.9	0.1
delayed	0.6	0.4

Calculate prediction of maintenance based on the evidence that the train was delayed

$$\begin{aligned} P(maintenance|train = delayed) = \alpha[&P(delayed, maintenance, rain = none)+ \\ &P(delayed, maintenance, rain = light)+ \\ &P(delayed, maintenance, rain = heavy)] \end{aligned}$$

$$= \alpha\langle\{P(none)P(yes|none)P(delayed|yes, none)+ \\ P(light)P(yes|light)P(delayed|yes, light)+ \\ P(heavy)P(yes|heavy)P(delayed|yes, heavy)\}, \\ \{P(none)P(no|none)P(delayed|no, none)+ \\ P(light)P(no|light)P(delayed|no, light)+ \\ P(heavy)P(no|heavy)P(delayed|no, heavy)\}\rangle$$

$$= \alpha\langle(0.7*0.4*0.2+0.2*0.2*0.4+0.1*0.1*0.6),(0.7*0.6*0.1+0.2*0.8*0.3+0.1*0.9*0.5)\rangle$$

$$= \alpha\langle 0.078, 0.135\rangle$$

$$= \alpha\langle 0.3661, 0.6338\rangle$$

$$Where \alpha = 0.213$$

maintenance :

$yes = 0.3661$

$no = 0.6338$

Calculate prediction of rain based on the evidence that the train was delayed

$$P(rain|train = delayed) = \alpha[P(delayed, rain, maintenance = yes)+ \\ P(delayed, rain, maintenance = no)]$$

$$= \alpha\langle\{P(none)P(yes|none)P(delayed|yes, none)+ \\ P(none)P(no|none)P(delayed|no, none)\}, \\ \{P(light)P(yes|light)P(delayed|yes, light)+ \\ P(light)P(no|light)P(delayed|no, light)\}, \\ \{P(heavy)P(yes|heavy)P(delayed|yes, heavy)+ \\ P(heavy)P(no|heavy)P(delayed|no, heavy)\}\rangle$$

$$= \alpha\langle(0.7*0.4*0.2+0.7*0.6*0.1),(0.2*0.2*0.4+0.2*0.8*0.3),(0.1*0.1*0.6+0.1*0.9*0.5)\rangle$$

$$= \alpha\langle 0.098, 0.064, 0.051\rangle$$

$$= \alpha\langle 0.46, 0.3, 0.24\rangle$$

$Where \alpha = 0.213$

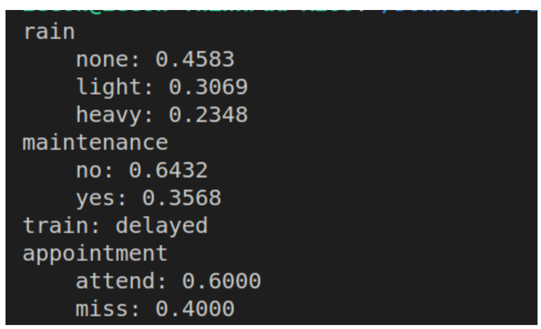
rain :

$none = 0.46$

$light = 0.3$

$heavy = 0.24$

Result after running inference.py



```
rain
    none: 0.4583
    light: 0.3069
    heavy: 0.2348
maintenance
    no: 0.6432
    yes: 0.3568
train: delayed
appointment
    attend: 0.6000
    miss: 0.4000
```