

# Assignment2: Bayesian Networks

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## Exercise 2.1 (Is your TA in the office?)

You want to discuss something with your TA. You know that:

1. the probability of your TA being in the office, assuming it is morning, is  $\frac{1}{5}$
2. if your TA is in the office, there is a  $\frac{1}{3}$  probability it is morning
3. the probabilities that it is morning or afternoon are both  $\frac{1}{2}$

Your tasks:

1. Write down the probabilities mentioned above as formulas

Let's  $\text{TAINOffice} \in \{\text{yes}, \text{no}\}$  and  $\text{TimesOfDay} \in \{\text{morning}, \text{afternoon}\}$ ,

then  $P(\text{TAINOffice} = \text{yes} | \text{TimesOfDay} = \text{morning}) = \frac{1}{5}$ ,

$P(\text{TimesOfDay} = \text{morning} | \text{TAINOffice} = \text{yes}) = \frac{1}{3}$

$P(\text{TimesOfDay} = \text{morning}) = P(\text{TimesOfDay} = \text{afternoon}) = \frac{1}{2}$

2. Compute the full joint probability distribution

- $P(\text{TAINOffice} = \text{yes}, \text{TimesOfDay} = \text{morning}) =$   
 $P(\text{TAINOffice} = \text{yes} | \text{TimesOfDay} = \text{morning}) \cdot P(\text{TimesOfDay} = \text{morning}) = \frac{1}{10}$
- $P(\text{TAINOffice} = \text{yes}, \text{TimesOfDay} = \text{afternoon}) =$   
 $P(\text{TAINOffice} = \text{yes} | \text{TimesOfDay} = \text{afternoon}) \cdot P(\text{TimesOfDay} = \text{afternoon}) =$   
 $P(\text{TimesOfDay} = \text{afternoon} | \text{TAINOffice} = \text{yes}) \cdot P(\text{TAINOffice} = \text{yes}) =$   
 $(1 - P(\text{TimesOfDay} = \text{morning} | \text{TAINOffice} = \text{yes})) \cdot P(\text{TAINOffice} = \text{yes})$   
Taking into account that  $P(\text{TAINOffice} = \text{yes}) =$   
 $\frac{P(\text{TAINOffice} = \text{yes} | \text{TimesOfDay} = \text{morning}) \cdot P(\text{TimesOfDay} = \text{morning})}{P(\text{TimesOfDay} = \text{morning} | \text{TAINOffice} = \text{yes})} = \frac{3}{10}$

$$P(\text{TAlnOffice} = \text{yes}, \text{TimesOfDay} = \text{afternoon}) = \frac{1}{5}$$

- $P(\text{TAlnOffice} = \text{no}, \text{TimesOfDay} = \text{morning}) =$   
 $P(\text{TAlnOffice} = \text{no} | \text{TimesOfDay} = \text{morning}) \cdot P(\text{TimesOfDay} = \text{morning}) =$   
 $(1 - P(\text{TAlnOffice} = \text{yes} | \text{TimesOfDay} = \text{morning})) \cdot P(\text{TimesOfDay} = \text{morning}) = \frac{2}{5}$
- $P(\text{TAlnOffice} = \text{no}, \text{TimesOfDay} = \text{afternoon}) =$   
 $P(\text{TAlnOffice} = \text{no} | \text{TimesOfDay} = \text{afternoon}) \cdot P(\text{TimesOfDay} = \text{afternoon}) =$   
 $(1 - P(\text{TAlnOffice} = \text{yes} | \text{TimesOfDay} = \text{afternoon})) \cdot P(\text{TimesOfDay} = \text{afternoon}) =$

$$(1 - \frac{(1 - P(\text{TimesOfDay} = \text{morning} | \text{TAlnOffice} = \text{yes})) \cdot P(\text{TAlnOffice} = \text{yes})}{P(\text{TimesOfDay} = \text{afternoon})}) \cdot P(\text{TimesOfDay} = \text{afternoon}) = \frac{3}{10}$$

TimesOfDay \ TAlnOffice	TAlnOffice	
	yes	no
morning	$\frac{1}{10}$	$\frac{2}{5}$
afternoon	$\frac{1}{5}$	$\frac{3}{10}$

3. What's the probability you'll meet your TA, if you come to the office in the afternoon?

$$\frac{P(\text{TAlnOffice} = \text{yes} | \text{TimesOfDay} = \text{afternoon})}{P(\text{TAlnOffice} = \text{yes}, \text{TimesOfDay} = \text{afternoon})} = \frac{2}{5}$$