

# Probabilistic Inference

Suppose we know the full distribution of 3 variables

	toothache		no toothache	
	catch	no catch	catch	no catch
cavity	.108	.012	.072	.008
no cavity	.016	.064	.144	.576

notice  
sum to 1

To compute the probability of some proposition just add entries:  $P(\text{cavity} \vee \text{toothache}) = .108 + .012 + .072 + .008 + .016 + .064 = .28$

If extra probability distribution of some random var from such a joint distribution called marginalization or summing out

Ex)  $P(\text{cavity}) = .108 + .012 + .072 + .008 = .2$

To get distribution of Y from joint distribution of  $Y \times Z$

compute  $P(Y) = \sum_z P(Y, z)$

## Independence

Support added weather to full distribution above.

Might want to know

Say that weather is independent of rest of variables  
 can write as

$$P(X|Y) = P(X) \quad \text{or} \quad P(Y|X) = P(Y)$$

$$\text{or} \quad P(X, Y) = P(X)P(Y)$$

## Baye's Rule

considers product rules:

$$P(a \wedge b) = P(a|b)P(b)$$

$$P(a \wedge b) = P(b|a)P(a)$$

Setting two RHS equal get

$$P(b|a) = \frac{P(a|b)P(b)}{P(a)}$$

Baye's rule

Underlies most AI  
 inference engines

Ex | Know ~~stiff neck~~ meningitis  
 $\Rightarrow$  stiff neck 50%  
 Know meningitis occurs in  $\frac{1}{50000}$  of times  
 patients  
 Know stiff neck complaints in  $\frac{1}{20}$  patients  
 Would like to know  $P(\text{meningitis} | \text{stiff neck})$   
 $= \frac{.5 \times \frac{1}{50000}}{1/20} = .0002$   
 Ed ~~know~~