

4/11/19

Thursday, April 11, 2019 1:30 PM

This, next time: (see syllabus) reading: see syllabus

Rev. T. Bayes (1760)

village  
some people (data)  
dying

possible causes  
• bad water  
• bad air  
• bad food  
• disease(s)

deterministic  
causality:  
probabilistic  
causality

cause → effect

unknown data  
 $P(\text{cause} | \text{effect}) = ?$   
 $P(\text{effect} | \text{cause}) = \text{easier/easy}$

$P(U|D) = ?$   $P(D|U)$   $P(D) > 0$   
 $P(U|D) = \frac{P(U \text{ and } D)}{P(D)} \rightarrow P(U \text{ and } D) = P(D) \cdot P(U|D)$

$P(D|U) = \frac{P(D \text{ and } U)}{P(U)} \rightarrow P(D \text{ and } U) = P(U) \cdot P(D|U)$

therefore

$P(D) \cdot P(U|D) = P(U) \cdot P(D|U)$

$P(U|D) = \frac{P(U) \cdot P(D|U)}{P(D)}$

$P(\text{unknown} | \text{data}) = \frac{P(\text{unknown}) \cdot P(\text{data} | \text{unknown})}{P(\text{data})}$

Bayes's Theorem for T/F propositions

$P(U | D) = \frac{P(U) \cdot P(D|U)}{P(D)}$

$P(\text{not } U | D) = \frac{P(\text{not } U) \cdot P(D|\text{not } U)}{P(D)}$

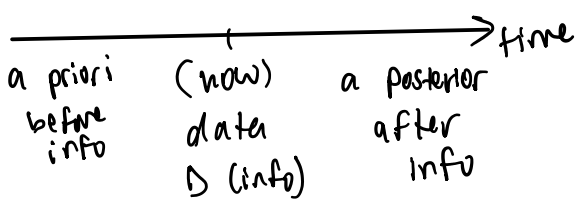
$\Rightarrow \left[ \frac{P(U|D)}{P(\text{not } U|D)} \right] = \left[ \frac{P(U)}{P(\text{not } U)} \right] \cdot \left[ \frac{P(D|U)}{P(D|\text{not } U)} \right]$   
posterior odds ratio given D      prior odds ratio in favor of U      Bayes factor

$P(H) = p$

$P(T) = 1 - p = P(\text{not } H)$

odds ratio against H =  $\frac{1-p}{p}$

$\frac{P(H)}{P(\text{not } H)} = \frac{p}{1-p}$  = odds ratio in favor of H



$0 = \frac{p}{1-p} \iff p = \frac{0}{1+0}$

Case Study: The Rasmussen Report aka "WASH 1400" aka "The reactor Safety Study"

problem: estimate p (catastrophic accident at nuclear power plant)

→ simpler events connected with (and), (or)

they assumed independence ⇒ huge underestimate

$P(\bigwedge_{i=1}^n A_i) \geq 1 - \sum_{i=1}^n P(A_i^c)$  useful in statistics

$n(n-1) \dots 1 = n!$  read "n factorial"