

CMP5 3520: Likelihood of Sufficiency (LS) & Likelihood of Necessity (LN), Certainty Factors

LS/LN

- ① IF 'today' is 'rain' {LS 2.5 LN 0.6}
THEN 'tomorrow' is 'rain' {prior 0.5}
- Bayes rule table enumeration is costly
 - Potentially: $(\text{num. rules})^{(2)^{(\# \text{ evidence vars.})}}$
 - LS/LN: Streamlined inference
 - Pseudo-probabilities: $O(H)$, $O(H|E)$
 - $LS = P(E|H) / P(E|\neg H)$
 - $LN = P(\neg E|H) / P(\neg E|\neg H)$
 - Use above formulas when calculating rationally, or given by expert
 - $O(H) = P(H) / (1 - P(H))$
 - used only if consequent was not previously asserted
 - $O(H|E) = LS \times O(H)$
 - $O(H|\neg E) = LN \times O(H)$
 - $P(H|E) = O(H|E) / (1 + O(H|E))$
 - $P(H|\neg E) = O(H|\neg E) / (1 + O(H|\neg E))$
 - Consequent asserted w/ appropriate posterror
 - When consequent asserted, $O(H)$ is now calculated w/ posterror

Following prev. example:

$$\textcircled{1} O(H) = \frac{0.5}{1-0.5} = 1.0$$

Lets say it is raining today

$$\begin{aligned} O(H|E) &= LS \times O(H) \\ &= 2.5(1.0) \\ &= 2.5 \end{aligned}$$

$$\begin{aligned} P(H|E) &= O(H|E) / (1 + O(H|E)) \\ &= 2.5 / (1 + 2.5) \\ &= 0.71 \end{aligned}$$

\Rightarrow 'tomorrow' is 'rain' asserted w/ 0.71

$\textcircled{2}$ IF 'today' is 'cloudy' { LS 2.0 LN 0.5 }

THEN 'tomorrow' is 'rain' { Prior 0.5 }

not used b/c
rain prev. asserted

$$O(H) = \frac{0.71}{1-0.71} = 2.45$$

Lets say it was not cloudy

$$\begin{aligned} O(H|\neg E) &= LN \times O(H) \\ &= 0.5(2.45) \\ &= 1.225 \end{aligned}$$

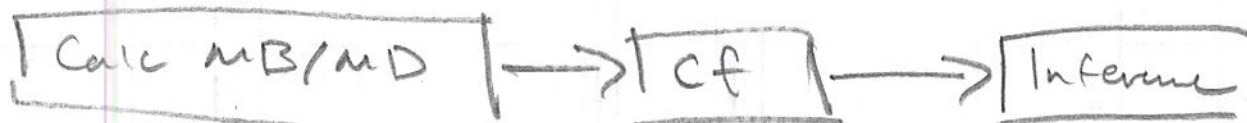
$$\begin{aligned} P(H|\neg E) &= O(H|\neg E) / (1 + O(H|\neg E)) \\ &= 1.225 / (1 + 1.225) \\ &= 0.55 \end{aligned}$$

\Rightarrow 'tomorrow' is 'rain' now 0.55

Certainty Factors

- Even more streamlined
- $cf \in [-1, 1]$

IF $\langle ev \rangle$
THEN $\langle hyp. \rangle \{cf\}$



(start here w/
expert)

$$MB = \begin{cases} 1, & \text{if } P(H) = 1 \\ \frac{\max(P(H|E), P(H)) - P(H)}{1 - P(H)}, & \text{otherwise} \end{cases}$$

$$MD = \begin{cases} 1, & \text{if } P(H) = 0 \\ \frac{\min(P(H|E), P(H)) - P(H)}{-P(H)}, & \text{otherwise} \end{cases}$$

$$cf = \frac{MB(H, E) - MD(H, E)}{1 - \min(MB(H, E), MD(H, E))}$$

$$cf(H, E) = \underbrace{cf(E)}_{\text{cf of evidence that has already been asserted}} \times \underbrace{cf}_{\text{cf of this rule}}$$

IF 'sky' is 'clear'

THEN 'forecast' is 'sunny' Σcf 0.83

Assume 'sky' is 'clear' asserted w/ cf 0.9

\Rightarrow 'forecast' is 'sunny' asserted w/ :

$$\begin{aligned} cf_{\text{forecast, sunny}} &= (0.9)(0.8) \\ &= 0.72 \end{aligned}$$