SOA and CAS: Exam P, Probability[1]
Chapter 4: Bayes' Theorem

Yi Li [2]

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(1) Recall we have already known that $P(A|B) = \frac{P(A \cap B)}{P(B)}$, where A stands for the initial event, B is the future event. If A is *mutually exclusive and exhausitve.* Then, we can write $P(B)$ as

$$P(B) = P(B \cap A_1) + P(B \cap A_2) + ... + P(B \cap A_n)$$

This gives $P(A|B)$ (the probability of "initial event A", given "future event B") is

$$\begin{aligned} P(A|B) &= \frac{P(A \cap B)}{P(B)} \\ &= \frac{P(A \cap B)}{P(B \cap A_1) + P(B \cap A_2) + ... + P(B \cap A_n)} \\ &= \frac{P(B|A) * P(A)}{P(B|A_1) * P(A_1) + P(B|A_2) * P(A_2) + ... + P(B|A_n) * P(A_n)} \end{aligned}$$

Note: "initial event A" should be mutually exclusive and exhausitve

If not, one can always use

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{P(B|A) * P(A)}{P(B)}$$

to calculate $P(A|B)$

(2) *Mutually Exclusive and Exhausitve* is equivalent to:

(2.a) Mutually Exclusive $\begin{cases} P(A \cup B) = P(A) + P(B) \\ P(A \cap B) = 0 \end{cases}$

(2.b) Mutually Exhausitve $\begin{cases} P(A_1) + P(A_2) + ... + P(A_n) = 1 \\ A_1 \cup A_2 \cup ... \cup \ A_n = \Omega \end{cases}$

DRAFT

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[2]Email: liyifinhub@outlook.com This note was drafted when I was preparing for the exam. Please email me if you find any errors. My personal website http://www.yilifinhub.com