Bayes Theorem: Takeaways

Concepts

- Independence, dependence, and exclusivity describe the relationship between events (two or more events), and they have different mathematical meanings:

$$\text{Independence} \implies P(A \cap B) = P(A) \times P(B)$$

$$\text{Dependence} \implies P(A \cap B) = P(A) \times P(B|A)$$

$$\text{Mutually Exclusive} \implies P(A \cap B) = 0$$

- If a set events are **exhaustive**, it means their union makes up the whole sample space Ω.
- If a set of events are both exhaustive and mutually exclusive, then they form a **partition** of Ω.
- **The Law of Total Probability** is an expression of a marginal probability in terms of a sum of conditional probabilities, given by:

$$P(A) = P(B_1) \times P(A|B_1) + P(B_2) \times P(A|B_2) + \ldots + P(B_n) \times P(A|B_n)$$

- The Law of Total Probability is more conveniently written using the summation sign Σ:

$$P(A) = \textstyle\sum_{i=1}^{n} P(B_i) \times P(A|B_i)$$

- For any events A and B, we can use **Bayes' theorem** to calculate the conditional probabilities $P(A|B)$ and $P(B|A)$:

$$P(A|B) = \frac{P(A) \times P(B|A)}{\displaystyle\sum_{i=1}^{n} P(A_i) \times P(B|A_i)}$$

- Bayes' Theorem is a mathematical representation of how people update their beliefs when they see new evidence. Given that we observed something, how much weight does this observation have in light of all the evidence I currently have and what I currently belive about it?

Resources

- An intuitive approach to understanding Bayes' theorem
- False positives, false negatives, and Bayes' theorem