Probability Rules Cheat sheet

📘 1. Basic Probability Definitions

Probability of an Event:

$$P(E) = \frac{\text{Number of favorable outcomes}}{\text{Total outcomes}}$$

- $0 \leq P(E) \leq 1$
- $P(S) = 1$ where S is the sample space
- $P(\emptyset) = 0$ (impossible event)

📕 2. Complement Rule

$$P(A') = 1 - P(A)$$

Where A' is the complement of event A (i.e., "not A")

📗 3. Addition Rules

General Addition Rule (for any events):

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Mutually Exclusive Events:

$$P(A \cup B) = P(A) + P(B) \quad (\text{if } A \cap B = \emptyset)$$

📕 4. Multiplication Rules

Independent Events:

$$P(A \cap B) = P(A) \cdot P(B)$$

Dependent Events:

$$P(A \cap B) = P(A) \cdot P(B \mid A)$$

📒 5. Conditional Probability

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}, \quad P(B) > 0$$

📓 6. Bayes' Theorem

$$P(A \mid B) = \frac{P(B \mid A) \cdot P(A)}{P(B)}$$

📔 7. Law of Total Probability

If $B_1, B_2, \ldots, B_n$ are mutually exclusive and exhaustive:

$$P(A) = \sum_{i=1}^{n} P(A \mid B_i) \cdot P(B_i)$$

📕 8. Independence Check

Two events A and B are independent if:

$$P(A \cap B) = P(A) \cdot P(B) \quad \text{or} \quad P(A \mid B) = P(A)$$

📒 9. Probability Bounds

- $0 \leq P(E) \leq 1$
- For **at least one** event to occur:

$$P(\text{at least one}) = 1 - P(\text{none})$$