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Probability and Stats Formula Sheet

- Distribution Law:
  - $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$
- De Morgan's Laws
  - $A' \cap B' = (A \cup B)'$
  - $A' \cup B' = (A \cap B)'$
- Standard Deviation
  - $\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$
- Corollaries of the Axioms
  - $P(A') = 1 - P(A)$
  - $P(S) = P(A) + P(A')$
  - $1 = P(A) + P(A')$
  - $P(A') = 1 - P(A)$
  - $P(\emptyset) = 0$
  - $P(S) = 1$
  - $P(A) \leq 1$
  - $1 = P(S) = P(A) + P(A') \geq P(A)$
- Permutations
  - $\frac{n!}{(n-r)!}$
- Combinations
  - $\frac{n!}{r!(n-r)!}$
- Multinomial Coefficients
  - $\frac{n!}{n_1! \cdot n_2! \cdot \ldots n_k!}$
- Conditional Probability
  - $P(A \mid B) = \frac{P(A \cap B)}{P(B)}$
- Independence Checks (Independent event if one of the following is true)
  - $P(A \mid B) = P(A)$
  - $P(B \mid A) = P(B)$
  - $P(A \cap B) = P(A)P(B)$
- Multiplicative Law of Probability

- $P(A \cap B) = P(A)P(B \mid A)$
  $P(B)P(A \mid B)$
- If they're independent events…
  $P(A \cap B) = P(A)\,P(B)$

- General Addition Rule
  - $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
  - If mutually exclusive:
    $P(A \cup \mathrm{B}) = \mathrm{P(A)} + \mathrm{P(B)}$

- Theorem 2.7
  - $P(A) = 1 - P(A')$

- Theorem of Total Probability
  - $P(A) = \sum_{i=1}^{n} P(A \mid B_i)P(B_i)$

- Bayes Theorem
  - If $P(A) > 0$ && $P(B) > 0$
    $P(B \mid A) = \frac{P(A \mid B)P(B)}{P(A)}$
  - If $0 < P(B) < 1$
    $P(B \mid A) = \frac{P(A \mid B)P(B)}{P(A \mid B)P(B) + P(A \mid B')P(B')}$

- Probability Mass Function
  - $p(y) = P(Y = y)$

- Expected
  - $E[Y] = \sum_{y \in Y} yp(y)$

- Variance
  - $V[Y] = E[(Y - \mu)^2]$

- PMF of Binomial Distribution
  - $p(y) \equiv P(Y = y) = \binom{n}{y} p^y q^{n-y}$

- PMF of Geometric Distribution
  - $p(y) \equiv P(Y = y) = q^{y-1}p$
  - Success occurs…
    - On or before nth trial
      $P(x \leq n) = 1 - (1 - p)^n$
    - Before the nth trial

$P(x < n) = 1 - (1 - p)^{n-1}$

- On or after the nth trial

  $P(x \geq n) = (1 - p)^{n-1}$

- After the nth trial

  $P(x > n) = (1 - p)^{n}$

- Def 3.5
  - $E(Y) = \frac{1}{p}$
  - $V(Y) = \frac{1-p}{p^2}$
- Theorem 3.7
  - $\mu = E(Y) = np$
  - $\sigma^2 = V(Y) = npq$