Probability Cheat Sheet

1. Basic Probability Concepts

- Definition of Probability: P(A) = Number of favorable outcomes / Total number of outcomes

- Complement Rule: P(A') = 1 - P(A)

- Addition Rule for Mutually Exclusive Events: P(A or B) = P(A) + P(B)

- General Addition Rule: P(A or B) = P(A) + P(B) - P(A and B)

- Conditional Probability: P(A | B) = P(A and B) / P(B)

- Multiplication Rule for Independent Events: P(A and B) = P(A) * P(B)

2. Common Probability Distributions

- Binomial: $P(X = k) = C(n, k) * p^k * (1 - p)^{(n - k)}$, where X ~ Binomial(n, p)

- Poisson: $P(X = k) = (\lambda^k * e^{(-\lambda)}) / k!$, where X ~ Poisson(lambda)

- Normal: $f(x) = (1 / \sqrt{2 * \pi * \sigma^2}) * e^{(- (x - \mu)^2 / (2 * \sigma^2))}$, where X ~ N(mu, sigma^2)

3. Bayes' Theorem and Applications

- Bayes' Theorem: P(A | B) = [P(B | A) * P(A)] / P(B)

- Application to Diagnostic Testing: P(Disease | Positive Test) = [P(Test Positive | Disease) * P(Disease)] / P(Test Positive)

4. Counting Principles

- Permutations: P(n, r) = n! / (n - r)!

- Combinations: C(n, r) = n! / [r! * (n - r)!]

5. Expected Value and Variance

- Expected Value (Discrete): E(X) = Sum of x * P(x)

- Variance: $Var(X) = E(X^2) - (E(X))^2$

6. Probability in Practice

- Law of Total Probability: $P(B) = \text{Sum of } P(B | A_i) * P(A_i)$

- Markov Inequality: P(X >= a) <= E(X) / a, for a > 0

- Chebyshev Inequality: $P(|X - \mu| >= k * \sigma) <= 1 / k^2$

7. Examples

- Example 1: Coin Toss Probability: What is the probability of getting at least 2 heads in 3 coin tosses?

  Use the binomial formula: $P(X >= 2) = P(X = 2) + P(X = 3)$

- Example 2: Bayes Theorem Application: If a test has 95 percent sensitivity and 90 percent specificity, and the disease

prevalence is 1 percent, what is the probability that a person who tested positive actually has the disease?

  Use Bayes theorem to compute: P(Disease | Positive Test)

8. Common Pitfalls

- Ignoring Conditional Probability: Remember that P(A | B) is not equal to P(B | A).

- Misunderstanding Independence: Two events are independent if $P(A \text{ and } B) = P(A) * P(B)$. Verify this before assuming

independence.

- Overlooking Complement Rule: Often, it is easier to calculate $P(A')$ and use $P(A) = 1 - P(A')$.

- Mixing Up Permutations and Combinations: Use permutations when order matters, combinations when it does not.