Statistics and Probability Formula Sheet

Comprehensive Quick-Reference Guide

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1. Descriptive Statistics

Sample Mean:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Sample Variance Standard Deviation:

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2, \quad s = \sqrt{s^2}$$

Coefficient of Variation (CV):

$$\text{CV} = \frac{s}{\bar{x}} \times 100\%$$

2. Probability Foundations

Axioms of Probability:

1. $0 \le P(A) \le 1$
2. $P(S) = 1$
3. If $A \cap B = \emptyset$, then $P(A \cup B) = P(A) + P(B)$

Addition Rule:

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

Conditional Probability:

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

Bayes' Theorem:

$$P(A_i \mid B) = \frac{P(B \mid A_i)P(A_i)}{\sum_j P(B \mid A_j)P(A_j)}$$

3. Random Variables

Expectation:

$$E[X] = \sum x \cdot P(X = x), \quad E[X] = \int_{-\infty}^{\infty} x f(x) dx$$

Variance:

$$\mathrm{Var}(X) = E[X^2] - (E[X])^2$$

4. Discrete Probability Distributions

Binomial Distribution: $X \sim \mathbf{Bin}(n, p)$

$$P(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$$

$$\mu = np, \quad \sigma^2 = np(1-p)$$

Poisson Distribution: $X \sim \mathbf{Poisson}(\lambda)$

$$P(X = k) = \frac{e^{-\lambda} \lambda^k}{k!}$$

$$\mu = \lambda, \quad \sigma^2 = \lambda$$

5. Continuous Distributions

Normal Distribution: $X \sim \mathcal{N}(\mu, \sigma^2)$

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

Standardization (Z-score):

$$Z = \frac{X - \mu}{\sigma} \sim \mathcal{N}(0, 1)$$

6. Inferential Statistics

Confidence Interval for Mean (σ known):

$$\bar{x} \pm z_{\alpha/2} \frac{\sigma}{\sqrt{n}}$$

Confidence Interval for Mean (σ unknown):

$$\bar{x} \pm t_{\alpha/2, n-1} \frac{s}{\sqrt{n}}$$