

Advanced Statistics Master Cheat Sheet

Comprehensive Summary for Academic Excellence

1. Descriptive Statistics

Mean (Sample / Population):

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i, \quad \mu = \frac{1}{N} \sum_{i=1}^N x_i$$

Variance & Standard Deviation:

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

Coefficient of Variation (CV): $CV = \frac{\sigma}{\mu} \times 100\%$

2. Probability Distributions

Binomial Distribution:

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

$\mu = np$, Variance $\sigma^2 = np(1-p)$. **Poisson Distribution:**

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

$= \text{Variance} = \lambda$. **Normal Distribution:**

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

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

3. Inferential Statistics

Central Limit Theorem (CLT): large samples ($n \geq 30$), the sampling distribution of the mean approaches normal:

$$\bar{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$$

Confidence Interval for Mean (σ known): $\bar{x} \pm$

$z_{\alpha/2} \frac{\sigma}{\sqrt{n}}$ Confidence Interval for Mean (σ unknown): $\bar{x} \pm$

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

4. Hypothesis Testing

1. Formulate H_0 (Null) and H_1 (Alternative). 2.

Choose significance level α (e.g., 0.05). 3. Calculate Test Statistic.

4. Compare p -value with α or critical value.

Common Test Statistics: * **Z-test:**

$Z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$ * **T-test:** $t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ * **Chi-Square (χ^2):**

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

5. Regression & Correlation

Pearson Correlation Coefficient (r):

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Simple Linear Regression:

$$y = \beta_0 + \beta_1 x + \epsilon$$

$$\beta_1 = r \frac{s_y}{s_x}, \quad \beta_0 = \bar{y} - \beta_1 \bar{x}$$