STAT PHYS SCIENCE Final Cheat Sheet

Noppakorn Jiravaranun

December 2, 2021

1 Continuous Random Distribution

1.1 Uniform Distribution

$$f(x) = \frac{1}{b-a}, a \leq x \leq b$$

$$\mu = E(x) = \frac{(a+b)}{2}$$

$$\sigma^2 = V(X) = \frac{(b-a)^2}{12}$$

1.2 Normal Distribution

$$E(X) = \mu$$

$$V(X) = \sigma^2$$

1.2.1 Standardizing a Normal Random Variable

$$Z = \frac{X-\mu}{\sigma}$$

$$P(X \leq x) = P(\frac{X-\mu}{\sigma} \leq \frac{x-\mu}{\sigma}) = P(Z < z)$$

1.3 Exponential Distribution

$$f(x) = \lambda e^{-\lambda x}, \text{ for } 0 \leq x < \infty$$

$$\mu = E(X) = \frac{1}{\lambda} \text{ and } \sigma^2 = V(x) = \frac{1}{\lambda^2}$$

1.4 Gamma Distribution

$$\mu = E(X) = \frac{r}{\lambda} \text{ and } \sigma^2 = V(X) = \frac{r}{\lambda^2}$$

2 Sampling Distribution

2.1 Probability Distribution of Mean ($\bar{X}$)

2.1.1 Known Variance

$$Z = \frac{\bar{X} - \mu_{\bar{X}}}{\frac{\sigma}{\sqrt{n}}}$$

2.1.2 $n \geq 30$

$$Z = \frac{\bar{X} - \mu_{\bar{X}}}{\frac{s}{\sqrt{n}}}$$

2.1.3 Unknown Variance

$$T = \frac{X - \mu}{\frac{S}{\sqrt{n}}}$$

has a t distribution with $n-1$ degree of freedom.

2.2 Probability Distribution of Difference of Mean ($\bar{X}_1 - \bar{X}_2$)

2.2.1 Central Limit Theorem ($n \geq 30$)

$$Z = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

2.2.2 $\sigma_1^2 = \sigma_2^2$

Random varaible T with degree of freedom $n_1 + n_2 - 2$

$$T = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{S_p^2(\frac{1}{n_1} + \frac{1}{n_2})}}$$

$$S_p^2 = \frac{(n-1)s_1^2 + (n-1)s_2^2}{n_1 + n_2 - 2}$$

2.2.3 $\sigma_1^2 \neq \sigma_2^2$

t distribution with degree of freedom

$$\nu = \frac{(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2})^2}{\frac{(s_1^2/n_1)^2}{n_1-1} + \frac{(s_2^2/n_2)^2}{n_2-1}}$$

$$T = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

2.2.4 Dependent data between two groups

$$T(n-1) = \frac{\bar{D} - \mu_D}{\frac{\sigma_D}{\sqrt{n}}} \text{ with } \sigma_D \approx S_D = \sqrt{\frac{\sum_{j=1}^{n} D_j^2 - nD^2}{n-1}}$$

2.3 Variance (S^2)

$$\chi^2(n-1) = \frac{(n-1)S^2}{\sigma^2}$$

2.4 Variance Ratio ($\frac{S_1^2}{S_2^2}$)

$$F = \frac{s_1^2/\sigma_1^2}{s_2^2/\sigma_2^2}$$

$$F(n_1 - 1, n_2 - 1) = \frac{S_1^2/\sigma_1^2}{S_2^2/\sigma_2^2}$$

2.5 Sample Ratio ($\hat{P}$)

$$Z = \frac{\hat{P} - P}{\sqrt{\frac{P(1-P)}{n}}}$$

2.6 Between Sample Ratio ($\hat{P}_1 - \hat{P}_2$)

$$Z = \frac{\hat{P}_1 - \hat{P}_2 - (P_1 - P_2)}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}}$$

3 ANOVA

$$SST = \sum_{i=1}^{k} \sum_{j=1}^{n_i} y_{ij}^2 - \frac{TT^2}{N}$$

4 Regression

4.1 Correlation Coefficient

$$S_{xy} = \sum_{i=1}^{n} (x_i y_i) - \frac{\sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n}$$

$$S_{xx} = \sum_{i=1}^{n} x_i^2 - \frac{(\sum_{i=1}^{n} x_i)^2}{n}$$

$$S_{xx} = \sum_{i=1}^{n} y_i^2 - \frac{(\sum_{i=1}^{n} y_i)^2}{n}$$

$$r = \frac{S_{xy}}{\sqrt{S_{xx} S_{yy}}}$$

4.2 Regression Analysis

$$\hat{y} = b_0 + b_1 x$$

$$b_1 = \frac{S_{xy}}{S_{xx}}$$

$$b_0 = \bar{y} - b_1 \bar{x}$$

$$SEE = \sqrt{\frac{S_{yy} - b_1 S_{xy}}{n-2}}$$

4.3 Coefficient of Determination

$$R^2 = \frac{b_1 S_{xy}}{S_{yy}}$$