Formula Sheet

Ranking of Scores: Percentiles and Percent Ranks

$$X_P = LRL + \left[\frac{(N)(P) - n_L}{n_W}\right] i \qquad PR_X = \left[\frac{n_L + (n_w / i)(X - LRL)}{N}\right](100)$$

Central Tendency

$$\bar{X} = \frac{\sum X}{n} \qquad \mu = \frac{\sum X}{N} \qquad Md = \frac{N+1}{2} \qquad Md = \frac{N}{2} \text{ and } Md = \frac{N+2}{2} \qquad Q = \left[\frac{\left(\frac{N+1}{2}\right)+1}{2}\right]$$

Sum of Squares (*SS*)

$$SS = \sum (X - \bar{X})^2 \qquad SS = \sum (X - \mu)^2$$

Variance

	Population	Sample	Population Estimate from Sample
Definitional:	$\sigma^2 = \frac{\sum (X - \mu)^2}{N}$	$s^2 = \frac{\sum (X - \bar{X})^2}{n}$	$\hat{s}^2 = \frac{\sum (X - \bar{X})^2}{n - 1}$
Conceptual:	$\sigma^2 = \frac{SS}{N}$	$s^2 = \frac{SS}{n}$	$\hat{s}^2 = \frac{SS}{n - 1}$

Standard Deviation

	Population	Sample	Population Estimate from Sample
Definitional:	$\sigma = \sqrt{\frac{\sum (X - \mu)^2}{N}}$	$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n}}$	$\hat{s} = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$
Conceptual:	$\sigma = \sqrt{\sigma^2}$	$s = \sqrt{s^2}$	$\hat{s} = \sqrt{\hat{s}^2}$

Standard (z) Scores

Population Data

$$z = \frac{X - \mu}{\sigma} \qquad X = z\sigma + \mu$$

Sample Data

$$z = \frac{X - \bar{X}}{s} \qquad X = zs + \bar{X}$$

Covariance Estimates

Definitional

$$\text{cov}_{xy} = \frac{\sum \left[(X - \bar{X})(Y - \bar{Y})\right]}{n - 1}$$

Conceptual

$$\text{cov}_{xy} = \frac{SCP}{n - 1}$$

Formula Sheet

Correlation

$$r_{xy} = \frac{\text{cov}_{xy}}{(\hat{s}_X)(\hat{s}_Y)} \qquad r_s = 1 - \frac{6\left(\sum D^2\right)}{N\left(N^2 - 1\right)} \qquad t = \frac{r}{\sqrt{(1-r^2)/(n-2)}} \qquad \sigma_{r'} = \frac{1}{\sqrt{n-3}} \qquad z = \frac{r' - \rho'}{\sigma_{r'}}$$

Regression

$$b = \frac{\text{cov}_{XY}}{\hat{s}_X^2} \qquad b = r_{XY}\left(\frac{\hat{s}_Y}{\hat{s}_X}\right) \qquad a = \bar{Y} - b_{XY}\bar{X}$$

	Definitional	Computational	Conceptual
Sum of Squares Regression:	$SS_{Reg} = \sum (Y' - \bar{Y})^2$	$SS_{Reg} = r^2 SS_Y$	---
Sum of Squares Residual:	$SS_{Resid} = \sum (Y - Y')^2$	$SS_{Resid} = (1-r^2) SS_Y$	---
Residual variance estimate:	$\hat{s}_{Y'}^2 = \frac{\sum (Y - Y')^2}{n-2}$	$\hat{s}_{Y'}^2 = \frac{SS_Y(1-r^2)}{n-2}$	$\hat{s}_{Y'}^2 = \frac{SS_{Resid}}{n-2}$
Standard error of estimate:	$\hat{s}_{Y'} = \sqrt{\frac{\sum (Y - Y')^2}{n-2}}$	$\hat{s}_{Y'} = \sqrt{\frac{SS_Y(1-r^2)}{n-2}}$	$\hat{s}_{Y'} = \sqrt{\hat{s}_{Y'}^2}$

$$SE(\text{b}_1) = \frac{\hat{s}_{Y'}}{\sqrt{SS_X}} \qquad SE(\text{b}_0) = \hat{s}_{Y'}\sqrt{\frac{1}{n} + \frac{\bar{X}^2}{SS_X}} \qquad t = \frac{b_1}{SE(b_1)} \qquad t = \frac{b_0}{SE(b_0)}$$

One Sample Statistics (z-Test and t-Test)

$$\sigma_{\bar{X}} = \frac{\sigma}{\sqrt{N}} \qquad \sigma_{\bar{X}} = \sqrt{\frac{\sigma^2}{N}} \qquad z = \frac{\bar{X} - \mu}{\sigma_{\bar{X}}} \qquad CI_\alpha = \bar{X} \pm z_\alpha \sigma_{\bar{x}}$$

$$\hat{s}_{\bar{X}} = \frac{\hat{s}}{\sqrt{n}} \qquad \hat{s}_{\bar{X}} = \sqrt{\frac{\hat{s}^2}{n}} \qquad t = \frac{\bar{X} - \mu}{\hat{s}_{\bar{X}}} \qquad CI_\alpha = \bar{X} \pm t_\alpha \hat{s}_{\bar{x}}$$

Independent Groups t-Test

$$\hat{s}_{\bar{X}_1 - \bar{X}_2} = \sqrt{\left(\frac{\hat{s}_{pooled}^2}{n_1} + \frac{\hat{s}_{pooled}^2}{n_2}\right)} \qquad \hat{s}_{pooled}^2 = \frac{(n_1 - 1)\hat{s}_1^2 + (n_2 - 1)\hat{s}_2^2}{n_1 + n_2 - 2} \qquad \hat{s}_{pooled}^2 = \frac{SS_1 + SS_2}{n_1 + n_2 - 2}$$

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{\hat{s}_{\bar{X}_1 - \bar{X}_2}} \qquad \eta^2 = \frac{SS_{Effect}}{SS_{Total}} \qquad \eta^2 = \frac{t^2}{t^2 + df} \qquad d = \left\|\frac{\bar{X}_1 - \bar{X}_2}{\hat{s}_{pooled}}\right\| \qquad CI_\alpha = (\bar{X}_1 - \bar{X}_2) \pm t_\alpha \hat{s}_{\bar{x}_1 - \bar{x}_2}$$

Formula Sheet

Correlated Samples t-Test

$$\hat{s}_{\bar{X}_1-\bar{X}_2}=\sqrt{\left(\frac{\hat{s}_1^2}{n_1}+\frac{\hat{s}_2^2}{n_2}\right)-2r\left(\frac{\hat{s}_1}{\sqrt{n_1}}\right)\left(\frac{\hat{s}_2}{\sqrt{n_2}}\right)}$$

$$t=\frac{\left(\bar{X}_1-\bar{X}_2\right)}{\hat{s}_{\bar{X}_1-\bar{X}_2}}$$

Counting Rules and the Binomial Expression

$${}_nC_r=\frac{n!}{(n-r)!(r!)} \qquad {}_nP_r=\frac{n!}{(n-r)!} \qquad p\left(r\,|\,p_{success},n\right)=\left[\frac{n!}{(n-r)!(r!)}\right]\left(p^r\right)\left(q^{n-r}\right)$$

$$\mu=np \qquad \sigma^2=npq \qquad \sigma=\sqrt{npq}$$

Chi-Square

$$f_E=\frac{n_{Total}}{k} \qquad f_E=\frac{(CMF)(RMF)}{n_{Total}} \qquad \chi^2=\frac{n(ad-bc)^2}{(a+b)(c+d)(a+c)(b+d)}$$

$$\chi^2=\sum\left(\frac{\left(f_O-f_E\right)^2}{f_E}\right) \qquad C=\sqrt{\frac{\chi^2}{n+\chi^2}} \qquad \Phi=\sqrt{\frac{\chi^2}{n}}$$

One-Way Between Subjects ANOVA

$$SS_W=\sum_{k=1}^{K}\sum_{i=1}^{n}\left(X_{ik}-\bar{X}_k\right)^2 \qquad SS_B=\sum_{k=1}^{K}n_k\left(\bar{X}_k-\bar{\bar{X}}\right)^2 \qquad SS_T=\sum_{k=1}^{K}\sum_{i=1}^{n}\left(X_{ik}-\bar{\bar{X}}\right)^2 \qquad MS=\frac{SS}{df}$$

$$F=\frac{MS_B}{MS_W} \qquad HSD=q\sqrt{\frac{MS_W}{n_{Group}}} \qquad LSD=t_\alpha\sqrt{MS_W\left(\frac{1}{n_1}+\frac{1}{n_2}\right)} \qquad \eta^2=\frac{SS_B}{SS_T}$$

Two-Way Between Subjects ANOVA (Note, *J* is used designate the rows and *K* the columns)

$$SS_T=\sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{n}\left(X_{ijk}-\bar{\bar{X}}\right)^2 \qquad SS_W=\sum_{k=1}^{K}\sum_{j=1}^{J}\sum_{i=1}^{n}\left(X_{ijk}-\bar{X}_{jk}\right)^2 \qquad SS_B=\sum_{jk=1}^{JK}n_{jk}\left(\bar{X}_{jk}-\bar{\bar{X}}\right)^2$$

$$SS_J=\sum_{j=1}^{J}n_j\left(\bar{X}_j-\bar{\bar{X}}\right)^2 \qquad SS_K=\sum_{k=1}^{K}n_k\left(\bar{X}_k-\bar{\bar{X}}\right)^2 \qquad SS_{J\times K}=\sum_{k=1}^{K}\sum_{j=1}^{J}n_{jk}\left(\bar{X}_{jk}-\bar{X}_{j\bullet}-\bar{X}_{\bullet k}+\bar{\bar{X}}\right)^2$$

$$\eta_x^2=\frac{SS_x}{SS_T}$$

Margins of Error Statistics

Single Category: $SE=\sqrt{\frac{p(1-p)}{n}}$ Difference between categories: $SE=\sqrt{\frac{p_1+p_2-(p_1-p_2)^2}{n}}$