**Hypothesis Testing**
Step 1) State the null and alternative hypothesis
Step 2) Calculate Test Statistic
Step 3) Determine significance level and rejection region.
$\alpha$=0.05 if not given
Step 4) Reject or Do Not Reject Null Hypothesis
Step 5) State Conclusion
-Reject $H_0$, there is evidence to support $H_1$ at $\alpha$ level of significance
-Do not reject $H_0$, there is not enough evidence to support $H_1$ at $\alpha$ level of significance

P-Value Rejection Method
1-Tail Test- Reject $H_0$ if P-value is less than $\alpha$
2-Tail Test - Reject $H_0$ if 2*P-value is less than $\alpha$

Confidence Interval Rejection Method: A 2-tail hypothesis can be rejected if the sample data is outside the confidence interval, or not rejected if it's inside the interval.

| Hypothesis Testing Errors | $H_0$ *True* (Person is innocent) | $H_0$ *False* (Person is not innocent) |
|---|---|---|
| Reject $H_0$ (Jury Convicts) | Type 1 Error Probability $= \alpha$ | Correct Decision |
| Do not reject $H_0$ (Jury Acquits) | Correct Decision | Type II Error Probability $= \beta$ |

**WHICH BOX SHOULD I USE? [For hypothesis testing or creating confidence intervals]**

| | |
|---|---|
| **Single Population - Data Type: Interval (Numbers)** | |
| 11.2 | Z-Test for a single sample mean ($\bar{x}$) if $\sigma$ is known |
| 12.1 | t-test for a single sample mean($\bar{x}$) if $\sigma$ is NOT known |
| 12.2 | $\chi^2$ test for a single sample variance or standard deviation |
| **Single Population - Data Type: Nominal (Categories)** | |
| 12.3 | Z-Test for proportions (when there are only 1 or 2 categories) |
| 15.1 | $\chi^2$ goodness of fit test where there are 2 or more categories |
| **Compare 2 Populations - Data Type: Interval (Numbers)** | |
| 13.1a | Comparing means? $\sigma$ is known? → Z-test for difference between means |
| 13.1b | Comparing means? Independent groups? $\sigma$ is unknown? Equal Variances?** → Equal variance t-test |
| 13.1c | Comparing means? Independent groups? $\sigma$ is unknown? Unequal Variances?**→ Unequal Variances t-test |
| 13.3 | Comparing means? Matched Pairs? → Mean of differences for matched pairs $t$-test |
| 13.4 | Comparing variability (variances or standard deviations)? → $F$ test to compare variances |
| ** | May have to perform test 13.4 to determine if variances are equal or unequal [Always 2 tail test] |
| **Compare 2 Populations - Data Type: Nominal (Categories)** | |
| 13.5 | 2 Categories? →Z-test for difference of proportions |
| 15.2 | 2 or more categories? Determine if there categories are dependent or independent? → $\chi^2$ Contingency table test. |
| **Compare 2+ Populations - Data Type: ?** | |
| 14.1 | Interval Data? Compare means of 2 or more populations? → ANOVA |
| 15.2 | Nominal Data? → $\chi^2$ Contingency table test. |
| **Determining If Relationship Exists Between Variables** | |
| 15.2 | Nominal Data? → $\chi^2$ Contingency table test. |
| 16.4a<br>16.4b | Interval Data? Is one variable independent and the other dependent? → Test for slope $\beta_1$ or Test for rho $\rho$ |
| 16.4b | Interval Data? → Test for rho $\rho$ |

**Distributions:** $Z$ vs $t$ vs $F$ vs $\chi^2$

| | |
|---|---|
| Z | Normal Distribution, symmetric |
| $t$ | Approaches Normal Distribution as df → ∞<br>Flatter and wider than normal as df → 1 |
| $F$ | Positively skewed, positive values only ( > 0)<br>Shape dependent on degrees of freedom |
| $\chi^2$ | Positively skewed, positive values only ( > 0)<br>Shape dependent on degrees of freedom<br>As df increases, becomes symmetric |

Other words for variability:
HiLo, Dispersion, Consistency, Accuracy

**Common Confidence Levels & Z-Values**

| Confidence Level $1-\alpha$ | Significance Level $\alpha$ | $z_\alpha$ | $\alpha/2$ | $z_{\alpha/2}$ |
|---|---|---|---|---|
| 0.90 (90%) | 0.10 (10%) | $z_{0.10}$=1.28 | 0.05 | $z_{0.05}$=1.645 |
| 0.95 (95%) | 0.05 (5%) | $z_{0.05}$=1.645 | 0.025 | $z_{0.025}$=1.96 |
| 0.98 (98%) | 0.02 (2%) | $z_{0.02}$=2.05 | 0.01 | $z_{0.01}$=2.33 |
| 0.99 (99%) | 0.01 (1%) | $z_{0.01}$=2.33 | 0.005 | $z_{0.005}$=2.575 |

Sample Size To Estimate A Mean
$n = \left(\frac{z_{\alpha/2}\,\sigma}{B}\right)^2$
Round your sample size up!

Sample Size To Estimate Proportion
$n = \left(\frac{z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})}}{B}\right)^2$
Round your sample size up

Sample Mean $\bar{x} = \frac{\sum x}{n}$

Sample Variance $s^2 = \frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}$

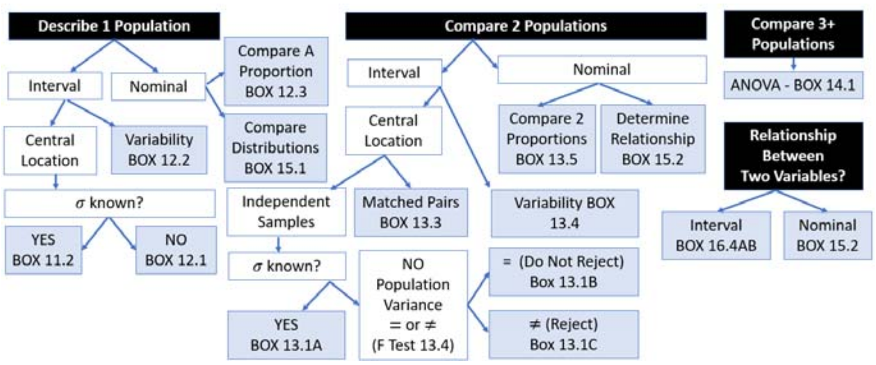
Sample Std. Dev. $s = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}}$

For population, divide by n instead of n-1

***Shortcut Formulas (Only for samples):***
Sample Variance $s^2 = \frac{1}{n-1}\left[\sum x_i^2 - \frac{(\sum x_i)^2}{n}\right]$
Sample Std. Dev. $s = \sqrt{\frac{1}{n-1}\left[\sum x_i^2 - \frac{(\sum x_i)^2}{n}\right]}$

Type II Error ($\beta$) & Power Calculation
Find the rejection region critical value in terms of $\bar{x}$ using the $\mu$ in the *null* hypothesis $\bar{x} = z\frac{\sigma}{\sqrt{n}} + \mu$
Use -$z_\alpha$ (left tail test) Use $z_\alpha$ (right tail test) Use $\pm z_{\alpha/2}$ (2 tail test)

Calculate the Z test statistic using the $\bar{x}$ value(s) from step 1 and the ***TRUE*** $\mu$
Use the Z values to find the probability of NOT being in the rejection region.
The rejection region is the based as what is stated in the alternative hypothesis.



| 11.2 | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\mu = \mu_0$ | $\mu = \mu_0$ | $\mu = \mu_0$ |
| $H_1$ | $\mu < \mu_0$ | $\mu \neq \mu_0$ | $\mu > \mu_0$ |
| Test Stat | $z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$ | | |
| Reject If… | $z < -z_\alpha$ | $z < -z_{\alpha/2}$ OR $z > z_{\alpha/2}$ | $z > z_\alpha$ |
| Conf. Limits | LCL $\bar{x} - z_{\alpha/2}\frac{\sigma}{\sqrt{n}}$ $UCL$ $\bar{x} + z_{\alpha/2}\frac{\sigma}{\sqrt{n}}$ | | |

| 12.1 | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\mu = \mu_0$ | $\mu = \mu_0$ | $\mu = \mu_0$ |
| $H_1$ | $\mu < \mu_0$ | $\mu \neq \mu_0$ | $\mu > \mu_0$ |
| Test Stat | $t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$ | | |
| Reject If… | $t < -t_{\alpha,v}$ | $t < -t_{\alpha/2,v}$ OR $t > t_{\alpha/2,v}$ | $t > t_{\alpha,v}$ |
| d.f. | $v = n - 1$ [Round down to nearest # in table] | | |
| Conf. Limits | LCL $\bar{x} - t_{\alpha/2,v},\frac{s}{\sqrt{n}}$ $UCL$ $\bar{x} + t_{\alpha/2,v}\frac{s}{\sqrt{n}}$ | | |

| 12.2 | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\sigma^2 = \#$ | $\sigma^2 = \#$ | $\sigma^2 = \#$ |
| $H_1$ | $\sigma^2 < \#$ | $\sigma^2 \neq \#$ | $\sigma^2 > \#$ |
| Test Stat | $\chi^2 = \frac{(n-1)s^2}{\sigma^2}$ | | |
| Reject If… | $\chi^2 < \chi^2_{1-\alpha,v}$ | $\chi^2 < \chi^2_{1-\alpha/2,v}$ OR $\chi^2 > \chi^2_{\alpha/2,v}$ | $\chi^2 > \chi^2_{\alpha,v}$ |
| d.f. | $v = n - 1$ | | |
| Conf. Limits | LCL $\frac{(n-1)s^2}{\chi^2_{\alpha/2,v}}$ $UCL$ $\frac{(n-1)s^2}{\chi^2_{1-\alpha/2},v}$ | | |

| 12.3 | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $p = \#$ | $p = \#$ | $p = \#$ |
| $H_1$ | $p < \#$ | $p \neq \#$ | $p > \#$ |
| Note | # must be a value between 0 and 1 inclusive | | |
| Test Stat | $z = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}}$ $\hat{p} = \frac{x}{n}$ $[if\ not\ given]$ | | |
| Reject If… | $z < -z_\alpha$ | $z < -z_{\alpha/2}$ OR $z > z_{\alpha/2}$ | $z > z_\alpha$ |
| Req'd | For z-test: use only if $np > 5$ and $n(1-p) > 5$ For Conf. Lim: use only if $n\hat{p} > 5$ and $n(1-\hat{p}) > 5$ | | |
| Conf. Limits | LCL $\hat{p} - z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ $UCL$ $\hat{p} + z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ | | |

| 13.1.a | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\mu_1 - \mu_2 = D$ | $\mu_1 - \mu_2 = D$ | $\mu_1 - \mu_2 = D$ |
| $H_1$ | $\mu_1 - \mu_2 < D$ | $\mu_1 - \mu_2 \neq D$ | $\mu_1 - \mu_2 > D$ |
| Note: | D is the difference between 2 means (usually 0 unless otherwise specified) | | |
| Test Stat | $z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$ | | |
| Reject If… | $z < -z_\alpha$ | $z < -z_{\alpha/2}$ OR $z > z_{\alpha/2}$ | $z > z_\alpha$ |
| Conf. Limits | LCL $(\bar{x}_1 - \bar{x}_2) - z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$ UCL $(\bar{x}_1 - \bar{x}_2) + z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$ | | |

| 13.1.b | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\mu_1 - \mu_2 = D$ | $\mu_1 - \mu_2 = D$ | $\mu_1 - \mu_2 = D$ |
| $H_1$ | $\mu_1 - \mu_2 < D$ | $\mu_1 - \mu_2 \neq D$ | $\mu_1 - \mu_2 > D$ |
| Note: | D is the difference between 2 means (usually 0 unless otherwise specified) | | |
| Test Stat | $t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$ $s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$ | | |
| Reject If… | $t < -t_{\alpha,v}$ | $t < -t_{\alpha/2,v}$ OR $t > t_{\alpha/2,v}$ | $t > t_{\alpha,v}$ |
| d.f. | $v = n_1 + n_2 - 2$ [Round down to nearest # in table] | | |
| Conf. Limits | LCL $(\bar{x}_1 - \bar{x}_2) - t_{\alpha/2,v}\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$ UCL $(\bar{x}_1 - \bar{x}_2) + t_{\alpha/2,v}\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$ | | |

| 15.2 | 1 – Tail Only (Right Tail) |
|---|---|
| $H_0$ | The two variables are independent |
| $H_1$ | The two variables are dependent (or not independent) |
| Test Stat | $\chi^2 = \sum\frac{(f-e)^2}{e}$ $e_{ij} = \frac{Row\ i\ total * Column\ j\ total}{Total\ Sample\ Size}$ both $f$ and $e$ are FREQUENCY, not a PROPORTION! |
| Reject If… | $\chi^2 > \chi^2_{\alpha,v}$ |
| d.f. | $v = (r-1)(c-1)$ r=# of rows, c=# of columns |
| Req'd | "Rule of 5", expected value for each cell must be $\geq 5$ |

| 13.1.c | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\mu_1 - \mu_2 = D$ | $\mu_1 - \mu_2 = D$ | $\mu_1 - \mu_2 = D$ |
| $H_1$ | $\mu_1 - \mu_2 < D$ | $\mu_1 - \mu_2 \neq D$ | $\mu_1 - \mu_2 > D$ |
| | D is the difference between 2 means (usually 0 unless otherwise specified) | | |
| Test Stat | $t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$ | | |
| Reject If… | $t < -t_{\alpha,v}$ | $t < -t_{\alpha/2,v}$ $OR$ $t > t_{\alpha/2,v}$ | $t > t_{\alpha,v}$ |
| d.f. | $v = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$ [Round down to # in table] | | |
| Conf. Limits | LCL $(\bar{x}_1 - \bar{x}_2) - t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ UCL $(\bar{x}_1 - \bar{x}_2) + t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ | | |

| 13.3 | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\mu_D = 0$ | $\mu_D = 0$ | $\mu_D = 0$ |
| $H_1$ | $\mu_D < 0$ | $\mu_D \neq 0$ | $\mu_D > 0$ |
| Note: | $\mu_D$ is the mean of the differences between the two groups | | |
| Test Stat | $t = \frac{\bar{x}_D - \mu_D}{\frac{s_D}{\sqrt{n_D}}}$ | | |
| Reject If… | $t < -t_{\alpha,v}$ | $t < -t_{\alpha/2,v}$ OR $t > t_{\alpha/2,v}$ | $t > t_{\alpha,v}$ |
| d.f. | $v = n_D - 1$ [Round down to nearest # in table] | | |
| Conf. Limits | LCL $\bar{x}_D - t_{\alpha/2,v}\frac{s_D}{\sqrt{n_D}}$ UCL $\bar{x}_D + t_{\alpha/2,v}\frac{s_D}{\sqrt{n_D}}$ | | |

| 13.4 | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\frac{\sigma_1^2}{\sigma_2^2} = 1$ | $\frac{\sigma_1^2}{\sigma_2^2} = 1$ | $\frac{\sigma_1^2}{\sigma_2^2} = 1$ |
| $H_1$ | $\frac{\sigma_1^2}{\sigma_2^2} < 1$ | $\frac{\sigma_1^2}{\sigma_2^2} \neq 1$ | $\frac{\sigma_1^2}{\sigma_2^2} > 1$ |
| Test Stat | $F = \frac{s_1^2}{s_2^2}$ | | |
| Reject If… | $F < \frac{1}{F_{\alpha,v_2,v_1}}$ | $F < \frac{1}{F_{\alpha/2,v_2,v_1}}$ or $F > F_{\alpha/2,v_1,v_2}$ | $F > F_{\alpha,v_1,v_2}$ |
| d.f. | $v_1 = n_1 - 1,\ v_2 = n_2 - 1$ [Round down in table] | | |
| Conf. Limits | LCL $\left(\frac{s_1^2}{s_2^2}\right)\frac{1}{F_{\alpha/2,v_1,v_2}}$ $UCL$ $\left(\frac{s_1^2}{s_2^2}\right)F_{\alpha/2,v_2,v_1}$ | | |

| 13.5 | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $p_1 - p_2 = D$ | $p_1 - p_2 = D$ | $p_1 - p_2 = D$ |
| $H_1$ | $p_1 - p_2 < D$ | $p_1 - p_2 \neq D$ | $p_1 - p_2 > D$ |
| Note: | $D$ is difference between the proportions (usually 0). | | |
| Test Stat | Use this if D=0 $z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$ $\hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$ | Use this if D $\neq$ 0 $z = \frac{(\hat{p}_1 - \hat{p}_2) - D}{\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}}$ | |
| Reject If… | $z < -z_\alpha$ | $z < -z_{\alpha/2}$ OR $z > z_{\alpha/2}$ | $z > z_\alpha$ |
| Req'd | $n_1\hat{p}_1 \geq 5$ $n_2\hat{p}_2 \geq 5$ | $n_1(1-\hat{p}_1) \geq 5$ $n_2(1-\hat{p}_2) \geq 5$ | |
| Conf. Limits | LCL $(\hat{p}_1 - \hat{p}_2) - z_{\alpha/2}\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$ UCL $(\hat{p}_1 - \hat{p}_2) + z_{\alpha/2}\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$ | | |

| 15.1 | 1 – Tail Only (Right Tail) |
|---|---|
| $H_0$ | $p_1 = \#, p_2 = \#, \ldots, p_k = \#$ |
| $H_1$ | Atleast one $p_i$ is not it's specified value |
| Note: | The # must be a number between 0 and 1 inclusive. |
| Test Stat | $\chi^2 = \sum\frac{(f-e)^2}{e}$ $e_i = np_i$ both $f$ and $e$ must be a FREQUENCY, not a PROPORTION! |
| Reject If… | $\chi^2 > \chi^2_{\alpha,v}$ |
| d.f. | $v = k - 1$ where $k$ is the number of categories |
| Req'd | "Rule of 5", expected value for each cell must be $\geq 5$ |

| 14.1 | 1 – Tail Only (Right Tail) |
|---|---|
| $H_0$ | $\mu_1 = \mu_2 = \mu_3 = \cdots = \mu_k$ [k is the number of groups we have] |
| $H_1$ | At least 2 means differ |
| Note: | Use ANOVA table below! |
| Test Stat | $F = \frac{MST}{MSE}$ |
| Reject If… | $F > F_{\alpha,v_1,v_2}$ |
| d.f. | where $v_1 = k - 1, v_2 = n - k$ |
| Req'd | Populations must be normal. Population variances must be equal. |

**14.1 ANOVA Table**

| Source Of Variation | Degrees Of Freedom | Sum Of Squares | Mean Squares | F-Statistic |
|---|---|---|---|---|
| **Treatments** *(between)* | $k - 1$ | $SST$ | $MST = \frac{SST}{k-1}$ | $F = \frac{MST}{MSE}$ |
| **Error** *(within)* | $n - k$ | $SSE$ | $MSE = \frac{SSE}{n-k}$ | |
| **Total** | $n - 1$ | SSTotal = SST+SSE | | |

$SST = n_1(\bar{x}_1 - \bar{\bar{x}})^2 + n_2(\bar{x}_2 - \bar{\bar{x}})^2 + \cdots + n_k(\bar{x}_k - \bar{\bar{x}})^2$
$SSE = (n_1 - 1)s_1^2 + (n_2 - 1)s_2^2 + \cdots + (n_k - 1)s_k^2$

$k$ = # of groups $n$ = Overall sample size $(n_1 + n_2 + \cdots n_k)$
$n_\#$ =Sample size of group # $s_\#^2$ = Variance of group #
$\bar{x}_\#$ = Mean of group #
$\bar{\bar{x}}$ = Grand Mean (Mean of all samples) = $\frac{n_1\bar{x}_1 + n_2\bar{x}_2 + \cdots + n_k\bar{x}_k}{n_1 + n_2 + \cdots + n_k}$

| 16.2 | Linear Regression |
|---|---|
| Model | $y = \beta_0 + \beta_1 x + \epsilon$ |
| Regression Line | $\hat{y} = b_0 + b_1 x$ |
| Coefficients | $b_1 = \frac{s_{xy}}{s_x^2}$ $[Slope]$ $b_0 = \bar{y} - b_1\bar{x}$ $[Intercept]$ |
| Covariance | $Cov(x,y) = s_{xy} = \frac{1}{n-1}\left[\sum x_i y_i - \frac{\sum x_i \sum y_i}{n}\right]$ |
| Variance of X | $s_x^2 = \frac{1}{n-1}\left[\sum x_i^2 - \frac{(\sum x_i)^2}{n}\right]$ |
| Variance of Y | $s_y^2 = \frac{1}{n-1}\left[\sum y_i^2 - \frac{(\sum y_i)^2}{n}\right]$ |
| Residual | $e_i = y_i - \hat{y}_i$ |
| Sum of Squares for Error | SSE $= \sum(y_i - \hat{y}_i)^2 = (n-1)\left(s_y^2 - \frac{s_{xy}^2}{s_x^2}\right)$ |
| Sum of Squares for Regression | SSR $= \sum(\hat{y}_i - \bar{y})^2$ |
| SSTotal | SSTotal = SSE+ SSR |
| Standard Error Of Estimate | $s_\epsilon = \sqrt{\frac{SSE}{n-2}}$ |
| Coefficient of Determination | $R^2 = \frac{s_{xy}^2}{s_x^2 s_y^2} = 1 - \frac{SSE}{\sum(y_i - \bar{y})^2} = 1 - \frac{SSE}{SST}$ |
| Coefficient of Correlation | $r = \sqrt{R^2} = \frac{s_{xy}}{s_x s_y} = \sqrt{1 - \frac{SSE}{\sum(y_i - \bar{y})^2}}$ |
| Prediction Interval | $\hat{y} \pm t_{\alpha/2,v}s_\epsilon\sqrt{1 + \frac{1}{n} + \frac{(x_g - \bar{x})^2}{(n-1)s_x^2}}$ $v = n - 2$ |
| Confidence Interval Estimate for Expected Value | $\hat{y} \pm t_{\alpha/2,v}s_\epsilon\sqrt{\frac{1}{n} + \frac{(x_g - \bar{x})^2}{(n-1)s_x^2}}$ $v = n - 2$ |

| $x_i$ | $y_i$ | $x_i y_i$ | $x_i^2$ | $y_i^2$ |
|---|---|---|---|---|
| <data> | <data> | Calculate | Calculate | Calculate |
| $\sum x_i =$ | $\sum y_{i=}$ | $\sum x_i y_i =$ | $\sum x_i^2 =$ | $\sum y_i^2 =$ |

**Test for Slope**

| 16.4a | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\beta_1 = 0$ | $\beta_1 = 0$ | $\beta_1 = 0$ |
| $H_1$ | $\beta_1 < 0$ Negative relationship | $\beta_1 \neq 0$ Some Linear Relationship | $\beta_1 > 0$ Positive Relationship |
| Test Stat | $t = \frac{(b_1 - \beta_1)}{s_{b_1}}$ $where\ s_{b_1} = \frac{s_\epsilon}{\sqrt{(n-1)s_x^2}}$ | | |
| Reject If… | $t < -t_{\alpha,v}$ | $t < -t_{\alpha/2,v}$ OR $t > t_{\alpha/2,v}$ | $t > t_{\alpha,v}$ |
| d.f. | $v = n - 2$ [Round down to nearest # in table] | | |
| Conf. Limits | LCL $b_1 - (t_{\alpha/2,v})s_{b_1}$ UCL $b_1 + (t_{\alpha/2,v})s_{b_1}$ | | |
| Note | Use to determine if a linear relationship exists between an **independent and dependent** variable (both must be normal) | | |

**Test for Coefficient of Correlation**

| 16.4b | 1-Tail (Left Tail) | 2 –Tail | 1 – Tail (Right Tail) |
|---|---|---|---|
| $H_0$ | $\rho = 0$ | $\rho = 0$ | $\rho = 0$ |
| $H_1$ | $\rho < 0$ Negative relationship | $\rho \neq 0$ Some Linear Relationship | $\rho > 0$ Positive Relationship |
| Test Stat | $t = r\sqrt{\frac{n-2}{1-r^2}}$ | | |
| Reject If… | $t < -t_{\alpha,v}$ | $t < -t_{\alpha/2,v}$ OR $t > t_{\alpha/2,v}$ | $t > t_{\alpha,v}$ |
| d.f. | $v = n - 2$ [Round down to nearest # in table] | | |
| Note: | Use to determine if a linear relationship exists between any two normally distributed variables. | | |