## Summary Table for Statistical Techniques

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| 1         | Estimating a Mean | One Population Mean $\mu$ | Sample mean $\bar{y}$ | Numerical | • What is the average weight of adults?  
• What is the average cholesterol level of adult females? | $1$-sample $t$-interval $\bar{y} \pm t_{\alpha/2} \frac{s}{\sqrt{n}}$ | Stat > Basic statistics > $1$-sample t | • data approximately normal  
or  
• have a large sample size ($n \geq 30$) |
| 2         | Test about a Mean | One Population Mean $\mu$ | Sample mean $\bar{y}$ | Numerical | • Is the average GPA of juniors at Penn State higher than 3.0?  
• Is the average Winter temperature in State College less than 42°F? | $H_0 : \mu = \mu_0$  
$H_a : \mu \neq \mu_0$ or $H_a : \mu > \mu_0$ or $H_a : \mu < \mu_0$  
The one sample $t$ test: $t = \frac{\bar{y} - \mu_0}{s/\sqrt{n}}$ | Stat > Basic statistics > $1$-sample t | • data approximately normal  
or  
• have a large sample size ($n \geq 30$) |
| 3         | Estimating a Proportion | One Population Proportion $\pi$ | Sample Proportion $\hat{\pi}$ | Categorical (Binary) | • What is the proportion of males in the world?  
• What is the proportion of students that smoke? | $1$-proportion $Z$-interval $\hat{\pi} \pm Z_{\alpha/2} \sqrt{\frac{\hat{\pi}(1-\hat{\pi})}{n}}$ | Stat > Basic statistics > $1$-sample proportion | • have at least 5 in each category |
| 4         | Test about a Proportion | One Population Proportion $\pi$ | Sample Proportion $\hat{\pi}$ | Categorical (Binary) | • Is the proportion of females different from 0.5?  
• Is the proportion of students who fail Stat 500 less than 0.1? | $H_0 : \pi = \pi_0$  
$H_a : \pi \neq \pi_0$ or $H_a : \pi > \pi_0$ or $H_a : \pi < \pi_0$  
The one proportion $Z$-test: $z = \frac{\hat{\pi} - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$ | Stat > Basic statistics > $1$-sample proportion | • $n \pi_0 \geq 5$ and $n(1-\pi_0) \geq 5$ |
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| 5 | Estimating the difference of two means | Difference in two population means $\mu_1 - \mu_2$ | Difference in two sample means $\bar{y}_1 - \bar{y}_2$ | Numerical | • How different are the mean GPAs of males and females?  
• How many fewer colds do vitamin C takers get, on average, than non vitamin C takers? | two-sample t-interval $(\bar{y}_1 - \bar{y}_2) \pm t_{\alpha/2} \times s.e.(\bar{y}_1 - \bar{y}_2)$ | Stat >Basic statistics >2-sample t | • Independent samples from the two populations  
• Data in each sample are about normal or large samples |
| 6 | Test to compare two means | Difference in two population means $\mu_1 - \mu_2$ | Difference in two sample means $\bar{y}_1 - \bar{y}_2$ | Numerical | • Do the mean pulse rates of exercisers and non-exercisers differ?  
• Is the mean EDS score for dropouts greater than the mean EDS score for graduates? | $H_0: \mu_1 = \mu_2$  
$H_1: \mu_1 \neq \mu_2$ or $H_2: \mu_1 > \mu_2$ or $H_3: \mu_1 < \mu_2$  
The two sample t test: $t = \frac{(\bar{y}_1 - \bar{y}_2) - 0}{s.e.(\bar{y}_1 - \bar{y}_2)}$ | Stat >Basic statistics >2-sample t | • Independent samples from the two populations  
• Data in each sample are about normal or large samples |
| 7 | Estimating a mean with paired data | Mean of paired difference $\mu_d$ | Sample mean of difference $\bar{d}$ | Numerical | • What is the difference in pulse rates, on the average, before and after exercise? | paired t-interval $\bar{d} \pm t_{\alpha/2} \frac{s_d}{\sqrt{n}}$ | Stat >Basic statistics >Paired t | • Differences approximately normal  
• Have a large number of pairs ($n \geq 30$) |
| 8 | Test about a mean with paired data | Mean of paired difference $\mu_d$ | Sample mean of difference $\bar{d}$ | Numerical | • Is the difference in IQ of pairs of twins zero?  
• Are the pulse rates of people higher after exercise? | $H_0: \mu_d = 0$  
$H_1: \mu_d \neq 0$ or $H_2: \mu_d > 0$ or $H_3: \mu_d < 0$  
$t = \frac{\bar{d} - 0}{s_d/\sqrt{n}}$ | Stat >Basic statistics >Paired t | • Differences approximately normal  
• Have a large number of pairs ($n \geq 30$) |
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<td>9 Estimating the difference of two proportions</td>
<td>Difference in two population proportions ( \pi_1 - \pi_2 )</td>
<td>Difference in two sample proportions ( \hat{\pi}_1 - \hat{\pi}_2 )</td>
<td>Categorical (Binary)</td>
<td>• How different are the percentages of male and female smokers? &lt;br&gt;• How different are the percentages of upper- and lower-class binge drinkers?</td>
<td>two-proportions Z-interval ( (\hat{\pi}_1 - \hat{\pi}<em>2 \pm z</em>{\alpha/2} \times \text{s.e.}(\hat{\pi}_1 - \hat{\pi}_2) )</td>
<td>Stat &gt; Basic statistics &gt; 2 proportions</td>
<td>• independent samples from the two populations &lt;br&gt;• have at least 5 in each category for both populations</td>
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<td>10 Test to compare two proportions</td>
<td>Difference in two population proportions ( \pi_1 - \pi_2 )</td>
<td>Difference in two sample proportions ( \hat{\pi}_1 - \hat{\pi}_2 )</td>
<td>Categorical (Binary)</td>
<td>• Is the percentage of males with lung cancer higher than the percentage of females with lung cancer? &lt;br&gt;• Are the percentages of upper- and lower-class binge drinkers different?</td>
<td>( H_0 : \pi_1 = \pi_2 )&lt;br&gt;( H_1 : \pi_1 \neq \pi_2 ) or ( H_1 : \pi_1 &gt; \pi_2 )&lt;br&gt;or ( H_1 : \pi_1 &lt; \pi_2 )&lt;br&gt;The two proportion z test: ( z = \frac{\hat{\pi}_1 - \hat{\pi}_2}{\sqrt{\hat{\pi}(1-\hat{\pi})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} )&lt;br&gt;where ( \hat{\pi} = \frac{y_1 + y_2}{n_1 + n_2} )</td>
<td>Stat &gt; Basic statistics &gt; 2 proportions</td>
<td>• independent samples from the two populations &lt;br&gt;• have at least 5 in each category for both populations</td>
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<td>11 Relationship in a 2-way table</td>
<td>Relationship between two categorical variables or difference in two or more population proportions</td>
<td>The observed counts in a two-way table</td>
<td>Categorical</td>
<td>• Is there a relationship between smoking and lung cancer? &lt;br&gt;• Do the proportions of students in each class who smoke differ?</td>
<td>( H_0 : \text{The two variables are not related} )&lt;br&gt;( H_1 : \text{The two variables are related} )&lt;br&gt;The chi-square statistic: ( \chi^2 = \sum_{\text{all cells}} \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}} )</td>
<td>Stat &gt; Tables &gt; Chi square Test</td>
<td>• all expected counts should be greater than 1 &lt;br&gt;• at least 80% of the cells should have an expected count greater than 5</td>
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| 12 Test about a slope | Slope of the population regression line \( \beta_1 \) | Sample estimate of the slope \( b_1 \) | Numerical | • Is there a linear relationship between height and weight of a person? | \( H_0: \beta_1 = 0 \)  \( H_a: \beta_1 \neq 0 \) or \( H_a: \beta_1 > 0 \) or \( H_a: \beta_1 < 0 \)  
\( t = \frac{b_1 - 0}{\text{s.e.}(b_1)} \) | Stat > Regression  > Regression | • The form of the equation that links the two variables must be correct  
• The error terms are normally distributed  
• The error terms have equal variances  
• The error terms are independent of each other |
| 13 Test to compare several means | Population means of the \( t \) populations \( \mu_1, \mu_2, \ldots, \mu_t \) | Sample means of the \( t \) populations \( x_1, x_2, \ldots, x_t \) | Numerical | • Is there a difference between the mean GPA of Freshman, Sophomore, Junior and Senior classes? | \( H_0: \mu_1=\mu_2=\ldots=\mu_t \)  \( H_a: \) not all the means are equal  
The F test for one-way ANOVA:  
\( F = \frac{\text{MSTR}}{\text{MSE}} \) | Stat > ANOVA  > Oneway | • Each population is normally distributed  
• Independent samples from the \( t \) populations  
• Equal population standard deviations |
| 14 Test to compare two population variances | Population variances of 2 populations \( \sigma_1^2, \sigma_2^2 \) | Sample variances of 2 populations \( s_1^2, s_2^2 \) | Numerical | • Are the variances of length of lumber produced by Company A different from those produced by Company B? | \( H_0: \sigma_1^2 = \sigma_2^2 \)  \( H_a: \sigma_1^2 \neq \sigma_2^2 \)  
\( F = \frac{s_1^2}{s_2^2} \) | Stat > ANOVA  > Test of Equal Variances | • Each population is normally distributed  
• Independent samples from the 2 populations |