Inference	*Parameter*	*Statistic*	*Type of Data*	*Analysis*	*Minitab Command*	*Conditions*	*Examples*
Estimating a mean	One population mean, μ	Sample mean, $\bar{x}$	Numerical	1-sample t-interval: $\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$	Stat > Basic statistics > 1-sample t	Data approximately normal OR have a large sample size (n ≥ 30)	What is the average weight of adults? What is the average cholesterol level of adult females?
Test about a mean	One population mean, μ	Sample mean, $\bar{x}$	Numerical	$H_0: \mu = \mu_0$ $H_a: \mu \neq \mu_0, OR$ $H_a: \mu > \mu_0, OR$ $H_a: \mu < \mu_0$ 1-sample t-test: $t = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}}$	Stat > Basic statistics > 1-sample t	Data approximately normal, OR have a large sample size (n ≥ 30)	Is the average GPA of juniors at Penn State higher than 3.0? Is the average Winter temperature in State College less than 42^0F?
Estimating a proportion	One population proportion, p	Sample proportion, $\hat{p}$	Categorical (binary)	1-proportion Z-interval: $\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$	Stat > Basic statistics > 1-sample proportion	Have at least 5 in each category	What is the proportion of males in the world? What is the proportion of students that smoke?
Test about a proportion	One population proportion, p	Sample proportion, $\hat{p}$	Categorical (binary)	$H_0: p = p_0$ $H_a: p \neq p_0, OR$ $H_a: p > p_0, OR$ $H_a: p < p_0$ 1-proportion Z-test: $z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$	Stat > Basic statistics > 1-sample proportion	$np_0 \geq 5$ *and* $n(1-p_0) \geq 5$	Is the proportion of females different from 0.5? Is the proportion of students who fail STAT 200 less than 0.1?

Inference	*Parameter*	*Statistic*	*Type of Data*	*Analysis*	*Minitab Command*	*Conditions*	*Examples*
Estimating the difference of two means*	Difference in two population means, $\mu_1 - \mu_2$	Difference in two sample means, $\bar{x}_1 - \bar{x}_2$	Numerical	2-sample t-interval: $\bar{x}_1 - \bar{x}_2 \pm t_{\alpha/2} \cdot \widehat{s.e.}(\bar{x}_1 - \bar{x}_2)$ *(the standard error (s.e.) will depend on pooled vs unpooled)	Stat > Basic statistics > 2-sample t	Independent samples from two populations Data in each sample are about normal or large samples	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?
Test to compare two means*	Difference in two population means, $\mu_1 - \mu_2$	Difference in two sample means, $\bar{x}_1 - \bar{x}_2$	Numerical	$H_0: \mu_1 = \mu_2$ $H_a: \mu_1 \neq \mu_2, OR$ $H_a: \mu_1 > \mu_2, OR$ $H_a: \mu_1 < \mu_2$ 2-sample t-test: $t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\widehat{s.e.}(\bar{x}_1 - \bar{x}_2)}$ *(the standard error (s.e.) will depend on pooled vs unpooled)	Stat > Basic statistics > 2-sample t	Independent samples from two populations Data in each sample are about normal or large samples	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?
Estimating a mean with paired data	Mean of paired difference, μ_D	Sample mean of difference, $\bar{d}$	Numerical	paired t-interval: $\bar{d} \pm t_{\alpha/2} \cdot \frac{s_d}{\sqrt{n}}$	Stat > Basic statistics > Paired t	Differences approximately normal, OR have a large number of pairs (n ≥ 30)	What is the difference in pulse rates, on the average, before and after exercise?
Test about a mean with paired data	Mean of paired difference, μ_D	Sample mean of difference, $\bar{d}$	Numerical	$H_0: \mu_D = 0$ $H_a: \mu_D \neq 0, OR$ $H_a: \mu_D > 0, OR$ $H_a: \mu_D < 0$ t-test statistic: $t = \frac{\bar{d} - 0}{\frac{s_d}{\sqrt{n}}}$	Stat > Basic statistics > Paired t	Differences approximately normal OR have a large number of pairs (n ≥ 30)	Is the difference in IQ of pairs of twins zero? Are the pulse rates of people higher after exercise?

Inference	*Parameter*	*Statistic*	*Type of Data*	*Analysis*	*Minitab Command*	*Conditions*	*Examples*
Estimating the difference of two proportions	Difference in two population proportions, $p_1 - p_2$	Difference in two sample proportions, $\hat{p}_1 - \hat{p}_2$	Categorical (binary)	2-Proportions Z -interval $\hat{p}_1 - \hat{p}_2 \pm z_{\alpha/2} \cdot \widehat{s.e.}(\hat{p}_1 - \hat{p}_2)$	Stat > Basic statistics > 2 proportions	Independent samples from the two populations Have at least 5 in each category for both populations	How different are the percentages of male and female smokers? How different are the percentages of upper and lower class binge drinkers?
Test to compare two proportions	Difference in two population proportions, $p_1 - p_2$	Difference in two sample proportions, $\hat{p}_1 - \hat{p}_2$	Categorical (binary)	$H_0: p_1 = p_2$ $H_a: p_1 \neq p_2, OR$ $H_a: p_1 > p_2, OR$ $H_a: p_1 < p_2$ 2-Proportion Z test: $z^* = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$ $\hat{p}^* = \frac{x_1 + x_2}{n_1 + n_2}$	Stat > Basic statistics > 2 proportions	Independent samples from the two populations Have at least 5 in each category for both populations	Is the percentage of males with lung cancer higher than the percentage of females with lung cancer? Are the percentages of upper- and lower- class binge drinkers different?
Relationship in a 2-way table	Relationship between two categorical variables, OR difference in two or more population proportions	The observed counts in a two-way table	Categorical	H_0: The two variables are not related H_a: The two variables are related Chi-square test statistic: $\chi^2 = \sum_{\substack{all \\ cells}} \frac{(Observed - Expected)^2}{Expected}$	Stat > Tables > Chi- Square Test for Association	All expected counts should be greater than 1 At least 80% of the cells should have an expected count greater than 5	Is there a relationship between smoking and lung cancer? Do the proportions of students in each class who smoke differ?
Test about a slope	Slope of the population regression line, β_1	Sample estimate of the slope, b_1	Numerical	$H_0: \beta_1 = 0$ $H_a: \beta_1 \neq 0, OR$ $H_a: \beta_1 > 0, OR$ $H_a: \beta_1 < 0$ t-test with n-2 degrees of freedom: $t = \frac{b_1 - 0}{\widehat{s.e.}(b_1)}$	Stat > Regression > Regression	The form of the equation that links the two variables must be correct The error terms are normally distributed	Is there a linear relationship between height and weight of a person?

Inference	*Parameter*	*Statistic*	*Type of Data*	*Analysis*	*Minitab Command*	*Conditions*	*Examples*
						The errors terms have equal variances The error terms are independent of each other	
Test to compare several means	Population means of the t populations, $\mu_1, \mu_2, \ldots, \mu_t$	Sample means of the t populations, $\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_t$	Numerical	$H_0: \mu_1 = \mu_2 = \cdots = \mu_t$ H_a: not all the means are equal F-test for one-way ANOVA: $F = \frac{MST}{MSE}$	Stat > ANOVA > One-way	Each population is normally distributed Independent samples from the t populations Equal population standard deviations	Is there a difference between the mean GPA of Freshman, Sophomore, Junior and Senior classes?
Test of Strength & Direction of Linear Relationship of 2 Quantitative Variables	Population correlation, ρ "rho"	Sample correlation, r	Numerical	$H_0: \rho = 0$ $H_a: \rho \neq 0$ t-test statistic: $t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$	Stat > Basic Statistics > Correlation	2 variables are continuous Related pairs No significant outliers Normality of both variables Linear relationship between the variables	Is there a linear relationship between height and weight?
Test to Compare Two Population Variances	Population variances of two populations, σ_1^2, σ_2^2	Sample variances of two populations, s_1^2, s_2^2	Numerical	$H_0: \sigma_1^2 = \sigma_2^2$ $H_a: \sigma_1^2 \neq \sigma_2^2$ F-test statistic: $F = \frac{s_1^2}{s_2^2}$	Stat > Basic statistics > 2 variances	Each population is normally distributed Independent sample from the 2 populations	Are the variances of length of lumber produced by Company A different from those produced by Company B?