Formulas and Distributions

Formula - Confidence Intervals

Parameter θ	Conditions	Confidence interval of the parameter
Mean μ	σ^2 known, Normal Dist.	$\bar{X} \pm z_{\alpha/2}\sqrt{\frac{\sigma^2}{n}}$
	σ^2 unknown, Normal Dist.	$\bar{X} \pm t_{\alpha/2}(n-1)\sqrt{\frac{s^2}{n}}$
	σ^2 unknown, large n	$\bar{X} \pm z_{\alpha/2}\sqrt{\frac{s^2}{n}}$
Mean Difference between Independent Populations $\mu_1 - \mu_2$	σ_1^2 and σ_2^2 known , Normal dist.,	$(\bar{X}_1 - \bar{X}_2) \pm z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$
	σ_1^2 and σ_2^2 unknown , large n	$(\bar{X}_1 - \bar{X}_2) \pm z_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$
	$\sigma_1^2 = \sigma_2^2$ unknown , Normal Dist.	$(\bar{X}_1 - \bar{X}_2) \pm t_{\alpha/2}(n_1+n_2-2)\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$ where $s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$
Paired Difference μ_D	Paired data, Normal Dist.	$\bar{D} \pm t_{\alpha/2}(n-1)\sqrt{\frac{s_D^2}{n}}$
Proportion p	$np > 5$	$\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$
Proportion Difference $p_1 - p_2$	Independent samples $np_1 > 5, np_2 > 5,$	$(\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2}\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$
Variance σ^2	Normal distribution	$\left(\frac{(n-1)s^2}{\chi^2_{\alpha/2}(n-1)}, \frac{(n-1)s^2}{\chi^2_{1-\alpha/2}(n-1)}\right)$
Variance Difference $\frac{\sigma_1^2}{\sigma_2^2}$	Independent Normal Distributions	$\left(\frac{s_1^2/s_2^2}{F_{\alpha/2}(n_1-1,\, n_2-1)}, \frac{s_1^2/s_2^2}{F_{1-\alpha/2}(n_1-1,\, n_2-1)}\right)$

Test Statistics in Section §4.1 - §4.6

$\mathbf{H_0}$	**Test Statistic**	$\mathbf{H_0}$	**Test Statistic**
$\mu = \mu_0$	σ^2 known, Normal dist. $z = \dfrac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$	$\mu = \mu_0$	σ^2 unknown and n large $z \approx \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}}$
$\mu = \mu_0$	σ^2 unknown and n small, Normal dist. $t = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}};\ df = n-1$	$\mu_1 - \mu_2 = 0$	σ_1^2 and σ_2^2 known , Normal dist. $z = \dfrac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$
$\mu_1 - \mu_2 = 0$	σ_1^2 and σ_2^2 unknown and n_1, n_2 "large" $z \approx \dfrac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$	$\mu_D = 0$ paired data	Differences are Normally Distributed $t = \dfrac{\bar{D}}{s_D/\sqrt{n}}, \quad df = n-1$
$\mu_1 - \mu_2 = 0$	$\sigma_1^2 = \sigma_2^2$ unknown, Normal Dist. $t = \dfrac{\bar{x}_1 - \bar{x}_2}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}, \quad df = n_1 + n_2 - 2$ $s_p^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}$	$\mu_1 - \mu_2 = 0$	$\sigma_1 \neq \sigma_2$; both unknown, n_1, n_2 "small" Normal Distributions Welch's t-test
$p = p_0$	Normal Approximation $\hat{p} = y/n$ $z \approx \dfrac{x - np_0}{\sqrt{np_0(1-p_0)}} = \dfrac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$	$p_1 = p_2$	Normal Approximation $\hat{p} = \dfrac{y_1 + y_2}{n_1 + n_2}$ $z \approx \dfrac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$
$\sigma_1^2 = \sigma_2^2$	Normal Distributions Independent Samples $F = s_1^2/s_2^2$ $df = n_1 - 1$ and $n_2 - 1$		

Chi-Squared Test in Section §4.7 : $\chi^2 = \sum \frac{(Observed - Expected)^2}{Expected}$

Test Hypotheses	**Test Statistic and Null Distribution**
$H_0 : p_i = p_{i0},\ i = 1, 2, \ldots, k\ vs\ H_1$: at least one case where $p_i \neq p_{i0}$	$\chi^2 = \sum_{i=1}^{k} \frac{(Y_i - np_{i0})^2}{np_{i0}} \sim \chi^2(k-1)$
Test for independence in a 2-way $a \times b$ contingency table	$\chi^2 = \sum_{i=1}^{a}\sum_{j=1}^{b} \frac{(y_{ij} - n\hat{p}_{i.}\hat{p}_{.j})^2}{n\hat{p}_{i.}\hat{p}_{.j}} \sim \chi^2((a-1)(b-1))$
Goodness-of-fit Test for a distribution with h unknown parameters	$\chi^2 = \sum_{i=1}^{k} \frac{(obs_i - exp_i)^2}{exp_i} \sim \chi^2(k-1-h)$