Table 4. Probability and Statistics Formulas (Continued)

Confidence Intervals

Parameter	Assumptions	$100(1-\alpha)\%$ Confidence Interval
μ	n large, σ^2 known, or normality, σ^2 known	$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$
μ	n large, σ^2 unknown	$\bar{x} \pm z_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$
μ	normality, n small, σ^2 unknown	$\bar{x} \pm t_{\alpha/2,n-1} \cdot \frac{s}{\sqrt{n}}$
p	binomial experiment, n large	$\hat{p} \pm z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}\hat{q}}{n}}$
σ^2	normality	$\left(\frac{(n-1)s^2}{\chi^2_{\alpha/2,n-1}}, \frac{(n-1)s^2}{\chi^2_{1-\alpha/2,n-1}}\right)$
$\mu_1 - \mu_2$	n_1, n_2 large, independence, σ_1^2, σ_2^2 known, or normality, independence, σ_1^2, σ_2^2 known	$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2} \cdot \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$
$\mu_1 - \mu_2$	n_1, n_2 large, independence, σ_1^2, σ_2^2 unknown	$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2} \cdot \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$
$\mu_1 - \mu_2$	normality, independence, σ_1^2, σ_2^2 unknown but equal, n_1, n_2 small	$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2,n_1+n_2-2} \cdot s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$ $s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$
$\mu_1 - \mu_2$	normality, independence, σ_1^2, σ_2^2 unknown, unequal, n_1, n_2 small	$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2,\nu} \cdot \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ $\nu = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{(s_1^2/n_1)^2}{n_1-1} + \frac{(s_2^2/n_2)^2}{n_2-1}}$ OR $\nu = \min(n_1-1, n_2-1)$
$\mu_D = \mu_1 - \mu_2$	normality, n pairs, n small, dependence	$\bar{d} \pm t_{\alpha/2,n-1} \cdot \frac{s_D}{\sqrt{n}}$
$p_1 - p_2$	binomial experiments, n_1, n_2 large, independence	$(\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_2\hat{q}_2}{n_2}}$
$\frac{\sigma_1^2}{\sigma_2^2}$	normality, independence	$\left(\frac{s_1^2}{s_2^2} \cdot \frac{1}{F_{\frac{\alpha}{2},n_1-1,n_2-1}}, \frac{s_1^2}{s_2^2} \cdot \frac{1}{F_{1-\frac{\alpha}{2},n_1-1,n_2-1}}\right)$

Table 4. Probability and Statistics Formulas (Continued)

Hypothesis Tests (One-Sample)

Null Hypothesis	Assumptions	Alternative Hypothesis	Test Statistic	Rejection Region
$\mu = \mu_0$	n large, σ^2 known, or normality, σ^2 known	$\mu > \mu_0$ $\mu < \mu_0$ $\mu \neq \mu_0$	$Z = \dfrac{\overline{X} - \mu_0}{\sigma/\sqrt{n}}$	$Z \geq z_\alpha$ $Z \leq -z_\alpha$ $\mid Z \mid \geq z_{\alpha/2}$
$\mu = \mu_0$	n large, σ^2 unknown	$\mu > \mu_0$ $\mu < \mu_0$ $\mu \neq \mu_0$	$Z = \dfrac{\overline{X} - \mu_0}{s/\sqrt{n}}$	$Z \geq z_\alpha$ $Z \leq -z_\alpha$ $\mid Z \mid \geq z_{\alpha/2}$
$\mu = \mu_0$	normality, n small, σ^2 unknown	$\mu > \mu_0$ $\mu < \mu_0$ $\mu \neq \mu_0$	$T = \dfrac{\overline{X} - \mu_0}{S/\sqrt{n}}$	$T \geq t_{\alpha,n-1}$ $T \leq -t_{\alpha,n-1}$ $\mid T \mid \geq t_{\alpha/2,n-1}$
$p = p_0$	binomial experiment, n large	$p > p_0$ $p < p_0$ $p \neq p_0$	$Z = \dfrac{\hat{p} - p_0}{\sqrt{p_0(1-p_0)/n}}$	$Z \geq z_\alpha$ $Z \leq -z_\alpha$ $\mid Z \mid \geq z_{\alpha/2}$
$\sigma^2 = \sigma_0^2$	normality	$\sigma^2 > \sigma_0^2$ $\sigma^2 < \sigma_0^2$ $\sigma^2 \neq \sigma_0^2$	$\chi^2 = \dfrac{(n-1)S^2}{\sigma_0^2}$	$\chi^2 \geq \chi^2_{\alpha,n-1}$ $\chi^2 \leq \chi^2_{1-\alpha,n-1}$ $\chi^2 \leq \chi^2_{1-\alpha/2,n-1}$ or $\chi^2 \geq \chi^2_{\alpha/2,n-1}$

Table 4. Probability and Statistics Formulas (Continued)

Hypothesis Tests (Two-Samples)

Null Hypothesis	Assumptions	Alternative Hypothesis	Test Statistic	Rejection Region
$\mu_1 - \mu_2 = \Delta_0$	n_1, n_2 large, independence, σ_1^2, σ_2^2 known, or normality, independence, σ_1^2, σ_2^2 known	$\mu_1 - \mu_2 > \Delta_0$ $\mu_1 - \mu_2 < \Delta_0$ $\mu_1 - \mu_2 \neq \Delta_0$	$Z = \dfrac{(\overline{X}_1 - \overline{X}_2) - \Delta_0}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$	$Z \geq z_\alpha$ $Z \leq -z_\alpha$ $\lvert Z \rvert \geq z_{\alpha/2}$
$\mu_1 - \mu_2 = \Delta_0$	n_1, n_2 large, independence, σ_1^2, σ_2^2 unknown	$\mu_1 - \mu_2 > \Delta_0$ $\mu_1 - \mu_2 < \Delta_0$ $\mu_1 - \mu_2 \neq \Delta_0$	$Z = \dfrac{(\overline{X}_1 - \overline{X}_2) - \Delta_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$	$Z \geq z_\alpha$ $Z \leq -z_\alpha$ $\lvert Z \rvert \geq z_{\alpha/2}$
$\mu_1 - \mu_2 = \Delta_0$	normality, independence, σ_1^2, σ_2^2 unknown, $\sigma_1^2 = \sigma_2^2$ n_1, n_2 small	$\mu_1 - \mu_2 > \Delta_0$ $\mu_1 - \mu_2 < \Delta_0$ $\mu_1 - \mu_2 \neq \Delta_0$	$T = \dfrac{(\overline{X}_1 - \overline{X}_2) - \Delta_0}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$ $S_p^2 = \dfrac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$	$T \geq t_{\alpha,n_1+n_2-2}$ $T \leq -t_{\alpha,n_1+n_2-2}$ $\lvert T \rvert \geq t_{\alpha/2,n_1+n_2-2}$
$\mu_1 - \mu_2 = \Delta_0$	normality, independence, σ_1^2, σ_2^2 unknown, $\sigma_1^2 \neq \sigma_2^2$ n_1, n_2 small	$\mu_1 - \mu_2 > \Delta_0$ $\mu_1 - \mu_2 < \Delta_0$ $\mu_1 - \mu_2 \neq \Delta_0$	$T' = \dfrac{(\overline{X}_1 - \overline{X}_2) - \Delta_0}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$ $\nu = \dfrac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{(s_1^2/n_1)^2}{n_1 - 1} + \frac{(s_2^2/n_2)^2}{n_2 - 1}}$ OR $\rightarrow$ $\nu = \min(n_1-1, n_2-1)$	$T' \geq t_{\alpha/2,\nu}$ $T' \leq -t_{\alpha/2,\nu}$ $\lvert T' \rvert \geq t_{\alpha/2,\nu}$
$\mu_D = \Delta_0$	normality, n pairs, n small, dependence	$\mu_D > \Delta_0$ $\mu_D < \Delta_0$ $\mu_D \neq \Delta_0$	$T = \dfrac{\overline{D} - \Delta_0}{S_D/\sqrt{n}}$	$T \geq t_{\alpha,n-1}$ $T \leq -t_{\alpha,n-1}$ $\lvert T \rvert \geq t_{\alpha/2,n-1}$
$p_1 - p_2 = 0$	binomial exps., n_1, n_2 large, independence	$p_1 - p_2 > 0$ $p_1 - p_2 < 0$ $p_1 - p_2 \neq 0$	$Z = \dfrac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}\hat{q}(1/n_1 + 1/n_2)}}$ $\hat{p} = \dfrac{X_1 + X_2}{n_1 + n_2}$	$Z \geq z_\alpha$ $Z \leq -z_\alpha$ $\lvert Z \rvert \geq z_{\alpha/2}$
$p_1 - p_2 = \Delta_0$	binomial exps., n_1, n_2 large, independence	$p_1 - p_2 > \Delta_0$ $p_1 - p_2 < \Delta_0$ $p_1 - p_2 \neq \Delta_0$	$Z = \dfrac{(\hat{p}_1 - \hat{p}_2) - \Delta_0}{\sqrt{\frac{\hat{p}_1\hat{q}_1}{n_1} + \frac{\hat{p}_2\hat{q}_2}{n_2}}}$	$Z \geq z_\alpha$ $Z \leq -z_\alpha$ $\lvert Z \rvert \geq z_{\alpha/2}$
$\sigma_1^2 = \sigma_2^2$	normality, independence	$\sigma_1^2 > \sigma_2^2$ $\sigma_1^2 < \sigma_2^2$ $\sigma_1^2 \neq \sigma_2^2$	$F = S_1^2/S_2^2$	$F \geq F_{\alpha,n_1-1,n_2-1}$ $F \leq F_{1-\alpha,n_1-1,n_2-1}$ $F \leq F_{1-\frac{\alpha}{2},n_1-1,n_2-1}$ or $F \geq F_{\frac{\alpha}{2},n_1-1,n_2-1}$