**Summary of One-Sample Hypothesis-Testing Procedures**

| Case | Null Hypothesis | Test Statistic | Alternative Hypothesis | Fixed Significance Level Criteria for Rejection | *P* - value | O.C. Curve Parameter | O.C. Curve Appendix Chart VII |
|---|---|---|---|---|---|---|---|
| 1. | $H_0: \mu = \mu_0$<br>$\sigma^2$ known | $z_0 = \dfrac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$ | $H_1: \mu \neq \mu_0$ | $\lvert z_0 \rvert > z_{\alpha/2}$ | $P = 2[1 - \Phi(z_0)]$ | $d = \lvert \mu - \mu_0 \rvert / \sigma$ | $a, b$ |
| | | | $H_1: \mu > \mu_0$ | $z_0 > z_\alpha$ | Probability above $z_0$<br>$P = 1 - \Phi(z_0)$ | $d = (\mu - \mu_0)/\sigma$ | $c, d$ |
| | | | $H_1: \mu < \mu_0$ | $z_0 < -z_\alpha$ | Probability below $z_0$<br>$P = \Phi(z_0)$ | $d = (\mu_0 - \mu)/\sigma$ | $c, d$ |
| 2. | $H_0: \mu = \mu_0$<br>$\sigma^2$ unknown | $t_0 = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}}$ | $H_1: \mu \neq \mu_0$ | $\lvert t_0 \rvert > t_{\alpha/2, n-1}$ | Sum of the probability above $\lvert t_0 \rvert$ and below $-\lvert t_0 \rvert$ | $d = \lvert \mu - \mu_0 \rvert / \sigma$ | $e, f$ |
| | | | $H_1: \mu > \mu_0$ | $t_0 > t_{\alpha, n-1}$ | Probability above $t_0$ | $d = (\mu - \mu_0)/\sigma$ | $g, h$ |
| | | | $H_1: \mu < \mu_0$ | $t_0 < -t_{\alpha, n-1}$ | Probability below $t_0$ | $d = (\mu_0 - \mu)/\sigma$ | $g, h$ |
| 3. | $H_0: \sigma^2 = \sigma_0^2$ | $x_0^2 = \dfrac{(n-1)s^2}{\sigma_0^2}$ | $H_1: \sigma^2 \neq \sigma_0^2$ | $\chi_0^2 > \chi_{\alpha/2, n-1}^2$<br>or<br>$\chi_0^2 < \chi_{1-\alpha/2, n-1}^2$ | See text Section 9.4. | $\lambda = \sigma/\sigma_0$ | $i, j$ |
| | | | $H_1: \sigma^2 > \sigma_0^2$ | $\chi_0^2 > \chi_{\alpha, n-1}^2$ | | $\lambda = \sigma/\sigma_0$ | $k, l$ |
| | | | $H_1: \sigma^2 < \sigma_0^2$ | $\chi_0^2 < \chi_{1-\alpha, n-1}^2$ | | $\lambda = \sigma/\sigma_0$ | $m, n$ |
| 4. | $H_0: p = p_0$ | $z_0 = \dfrac{x - np_0}{\sqrt{np_0(1-p_0)}}$ | $H_1: p \neq p_0$ | $\lvert z_0 \rvert > z_{\alpha/2}$ | $p = 2[1 - \Phi(z_0)]$ | 3–4 | 3–4 |
| | | | $H_1: p > p_0$ | $z_0 > z_\alpha$ | Probability above $z_0$<br>$p = 1 - \Phi(z_0)$ | 3–4 | 3–4 |
| | | | $H_1: p < p_0$ | $z_0 < -z_\alpha$ | Probability below $z_0$<br>$P = \Phi(z_0)$ | 3–4 | 3–4 |

**Summary of One-Sample Confidence Interval Procedures**

| Case | Problem Type | Point Estimate | Two-sided $100(1-\alpha)$ Percent Confidence Interval |
|---|---|---|---|
| 1. | Mean $\mu$, variance $\sigma^2$ known | $\bar{x}$ | $\bar{x} - z_{\alpha/2}\sigma/\sqrt{n} \leq \mu \leq \bar{x} + z_{\alpha/2}\sigma/\sqrt{n}$ |
| 2. | Mean $\mu$ of a normal distribution, variance $\sigma^2$ unknown | $\bar{x}$ | $\bar{x} - t_{\alpha/2, n-1}\, s/\sqrt{n} \leq \mu \leq \bar{x} + t_{\alpha/2, n-1} s/\sqrt{n}$ |
| 3. | Variance $\sigma^2$ of a normal distribution | $s^2$ | $\dfrac{(n-1)s^2}{\chi_{\alpha/2, n-1}^2} \leq \sigma^2 \leq \dfrac{(n-1)s^2}{\chi_{1-\alpha/2, n-1}^2}$ |
| 4. | Proportion or parameter of a binomial distribution $p$ | $\hat{p}$ | $\hat{p} - z_{\alpha/2}\sqrt{\dfrac{\hat{p}(1-\hat{p})}{n}} \leq p \leq \hat{p} + z_{\alpha/2}\sqrt{\dfrac{\hat{p}(1-\hat{p})}{n}}$ |

**Summary of Two-Sample Hypothesis-Testing Procedures**

| Case | Null Hypothesis | Test Statistic | Alternative Hypothesis | Fixed Significance Level Criteria for Rejection | *P* - value | O.C. Curve Parameter | O.C. Curve Appendix Chart VII |
|---|---|---|---|---|---|---|---|
| 1. | $H_0: \mu_1 - \mu_2 = \Delta_0$<br>$\sigma_1^2$ and $\sigma_2^2$ known | $z_0 = \dfrac{\bar{x}_1 - \bar{x}_2 - \Delta_0}{\sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}}$ | $H_1: \mu_1 - \mu_2 \neq \Delta_0$ | $\lvert z_0 \rvert > z_{\alpha/2}$ | $P = 2[1 - \Phi(z_0)]$ | $d = \dfrac{\lvert \mu_1 - \mu_2 - \Delta_0 \rvert}{\sqrt{\sigma_1^2 + \sigma_2^2}}$ | $a, b$ |
| | | | $H_1: \mu_1 - \mu_2 > \Delta_0$ | $z_0 > z_\alpha$ | Probability above $z_0$<br>$P = 1 - \Phi(z_0)$ | $d = \dfrac{\mu_1 - \mu_2 - \Delta_0}{\sqrt{\sigma_1^2 + \sigma_2^2}}$ | $c, d$ |
| | | | $H_1: \mu_1 - \mu_2 < \Delta_0$ | $z_0 < -z_\alpha$ | Probability below $z_0$<br>$P = \Phi(z_0)$ | $d = \dfrac{\mu_2 - \mu_1 - \Delta_0}{\sqrt{\sigma_1^2 + \sigma_2^2}}$ | $c, d$ |
| 2. | $H_0: \mu_1 - \mu_2 = \Delta_0$<br>$\sigma_1^2 = \sigma_2^2$ unknown | $t_0 = \dfrac{\bar{x}_1 - \bar{x}_2 - \Delta_0}{s_p\sqrt{\dfrac{1}{n_1} + \dfrac{1}{n_2}}}$ | $H_1: \mu_1 - \mu_2 \neq \Delta_0$ | $\lvert t_0 \rvert > t_{\alpha/2, n_1+n_2-2}$ | Sum of the probability above $\lvert t_0 \rvert$ and below $-\lvert t_0 \rvert$ | $d = \lvert \Delta - \Delta_0 \rvert / 2\sigma$ | $e, f$ |
| | | | $H_1: \mu_1 - \mu_2 > \Delta_0$ | $t_0 > t_{\alpha, n_1+n_2-2}$ | Probability above $t_0$ | $d = (\Delta - \Delta_0)/2\sigma$ | $g, h$ |
| | | | $H_1: \mu_1 - \mu_2 < \Delta_0$ | $t_0 < -t_{\alpha, n_1+n_2-2}$ | Probability below $t_0$ | $d = (\Delta_0 - \Delta)/2\sigma$<br>where $\Delta = \mu_1 - \mu_2$ | $g, h$ |
| 3. | $H_0: \mu_1 - \mu_2 = \Delta_0$<br>$\sigma_1^2 \neq \sigma_2^2$ unknown | $t_0 = \dfrac{\bar{x}_1 - \bar{x}_2 - \Delta_0}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}}$<br>$v = \dfrac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{(s_1^2/n_1)^2}{n_1 - 1} + \dfrac{(s_2^2/n_2)^2}{n_2 - 1}}$ | $H_1: \mu_1 - \mu_2 \neq \Delta_0$ | $\lvert t_0 \rvert > t_{\alpha/2, v}$ | Sum of the probability above $\lvert t_0 \rvert$ and below $-\lvert t_0 \rvert$ | 3–4 | 3–4 |
| | | | $H_1: \mu_1 - \mu_2 > \Delta_0$ | $t_0 > t_{\alpha, v}$ | Probability above $t_0$ | 3–4 | 3–4 |
| | | | $H_1: \mu_1 - \mu_2 < \Delta_0$ | $t_0 < -t_{\alpha, v}$ | Probability below $t_0$ | 3–4 | 3–4 |
| 4. | Paired data<br>$H_0: \mu_D = 0$ | $t_0 = \dfrac{\bar{d}}{s_d/\sqrt{n}}$ | $H_1: \mu_d \neq 0$ | $\lvert t_0 \rvert > t_{\alpha/2, n-1}$ | Sum of the probability above $\lvert t_0 \rvert$ and below $-\lvert t_0 \rvert$ | 3–4 | 3–4 |
| | | | $H_1: \mu_d > 0$ | $t_0 > t_{\alpha, n-1}$ | Probability above $t_0$ | 3–4 | 3–4 |
| | | | $H_1: \mu_d < 0$ | $t_0 < -t_{\alpha, n-1}$ | Probability below $t_0$ | 3–4 | 3–4 |
| 5. | $H_0: \sigma_1^2 = \sigma_2^2$ | $f_0 = s_1^2/s_2^2$ | $H_1: \sigma_1^2 \neq \sigma_2^2$ | $f_0 > f_{\alpha/2, n_1-1, n_2-1}$<br>or<br>$f_0 < f_{1-\alpha/2, n_1-1, n_2-1}$ | See text Section 10-5.2. | $\lambda = \sigma_1/\sigma_2$ | $o, p$ |
| | | | $H_1: \sigma_1^2 > \sigma_2^2$ | $f_0 > f_{\alpha, n_1-1, n_2-1}$ | | $\lambda = \sigma_1/\sigma_2$ | $q, r$ |
| 6. | $H_0: p_1 = p_2$ | $z_0 = \dfrac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\left[\dfrac{1}{n_1} + \dfrac{1}{n_2}\right]}}$ | $H_1: p_1 \neq p_2$ | $\lvert z_0 \rvert > z_{\alpha/2}$ | $P = 2[1 - \Phi(z_0)]$ | 3–4 | 3–4 |
| | | | $H_1: p_1 > p_2$ | $z_0 > z_\alpha$ | Probability above $z_0$<br>$P = 1 - \Phi(z_0)$ | 3–4 | 3–4 |
| | | | | $z_0 < -z_\alpha$ | Probability below $z_0$<br>$P = \Phi(z_0)$ | 3–4 | 3–4 |

**Summary of Two-Sample Confidence Interval Procedures**

| Case | Problem Type | Point Estimate | |
|---|---|---|---|
| 1. | Difference in two means $\mu_1$ and $\mu_2$, variances $\sigma_1^2$ and $\sigma_2^2$ known | $\bar{x}_1 - \bar{x}_2$ | $\bar{x}_1 - \bar{x}_2 - z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \le \mu_1 - \mu_2$ <br> $\le \bar{x}_1 - \bar{x}_2 + z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$ |
| 2. | Difference in means of two normal distributions $\mu_1 - \mu_2$, variances $\sigma_1^2 = \sigma_2^2$ and unknown | $\bar{x}_1 - \bar{x}_2$ | $\bar{x}_1 - \bar{x}_2 - t_{\alpha/2, n_1+n_2-2}s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} \le \mu_1 - \mu_2$ <br> $\le \bar{x}_1 - \bar{x}_2 + t_{\alpha/2, n_1+n_2-2}s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$ <br> where $s_p = \sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}}$ |
| 3. | Difference in means of two normal distributions $\mu_1 - \mu_2$, variances $\sigma_1^2 \ne \sigma_2^2$ and unknown | $\bar{x}_1 - \bar{x}_2$ | $\bar{x}_1 - \bar{x}_2 - t_{\alpha/2, v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \le \mu_1 - \mu_2$ <br> $\le \bar{x}_1 - \bar{x}_2 + t_{\alpha/2, v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ <br> where $v = \dfrac{(s_1^2/n_1 + s_2^2/n_2)^2}{\frac{(s_1^2/n_1)^2}{n_1 - 1} + \frac{(s_2^2/n_2)^2}{n_2 - 1}}$ |
| 4. | Difference in means of two normal distributions for paired samples $\mu_0 = \mu_1 - \mu_2$ | $\bar{d}$ | $\bar{d} - t_{\alpha/2, n-1}s_d/\sqrt{n} \le \mu_D \le \bar{d} + t_{\alpha/2, n-1}s_d/\sqrt{n}$ |
| 5. | Ratio of the variances $\sigma_1^2/\sigma_2^2$ of two normal distributions | $\frac{s_1^2}{s_2^2}$ | $\frac{s_1^2}{s_2^2} f_{1-\alpha/2, n_2-1, n_1-1} \le \frac{\sigma_1^2}{\sigma_2^2} \le \frac{s_1^2}{s_2^2} f_{\alpha/2, n_2-1, n_1-1}$ <br> where $f_{1-\alpha/2, n_2-1, n_1-1} = \frac{1}{f_{\alpha/2, n_1-1, n_2-1}}$ |
| 6. | Difference in two proportions of two binominal parameters $p_1 - p_2$ | $\hat{p}_1 - \hat{p}_2$ | $\hat{p}_1 - \hat{p}_2 - z_{\alpha/2}\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$ <br> $\le p_1 - p_2 \le \hat{p}_1 - \hat{p}_2 + z_{\alpha/2}\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$ |