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Formulas for inferential statistics

Some facts about inference for means and proportions

A common format

- Several types of confidence intervals for population means and population proportions follow the general format

  estimate $\pm$ (critical value) (spread) ,

  in which **estimate** is the value of a statistic used to estimate of the population parameter(s), **spread** is the standard deviation or standard error of the statistic, and **critical value** is a number that depends on the level of confidence and the sampling distribution of the statistic.

- Several hypothesis tests for population means and population proportions employ a test statistic of the form

  $$\frac{\text{estimate - parameter}}{\text{spread}},$$

  in which **estimate** and **spread** are as above, and **parameter** is the population parameter of interest.

Specific situations

Inference situation	Estimating statistic	Standard deviation or standard error
• Estimating μ (via a confidence interval) or testing whether μ		

equals a certain value • Known σ • Normal population or n large	$\bar{x}$	$\frac{\sigma}{\sqrt{n}}$
• Estimating μ (via a confidence interval) or testing whether μ equals a certain value • Unknown σ • Normal population	$\bar{x}$	$\frac{s}{\sqrt{n}}$
• Estimating p (via a confidence interval) • $np > 5$ and $n(1-p)>5$	$\hat{p}$	$\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$
• Testing whether $p=p_0$ • $np > 5$ and $n(1-p)>5$	$\hat{p}$	$\sqrt{\frac{p_0(1-p_0)}{n}}$
• Estimating $\mu_1-\mu_2$ (via a confidence interval) or testing whether $\mu_1=\mu_2$ • Known σ_1^2 and σ_2^2 • Normal populations or n_1 and n_2 large	$\bar{x}_1-\bar{x}_2$	$\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}$
• Estimating $\mu_1-\mu_2$ (via a confidence interval) or testing whether $\mu_1=\mu_2$ • Unknown σ_1^2 and σ_2^2 • n_1 and n_2 large	$\bar{x}_1-\bar{x}_2$	$\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}$
• Estimating $\mu_1-\mu_2$ (via a confidence interval) or testing whether $\mu_1=\mu_2$	$\bar{x}_1-\bar{x}_2$	$\sqrt{s_p^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}$

• Unknown σ_1^2 and σ_2^2; $\sigma_1^2 = \sigma_2^2$ • Normal populations		$s_p^2 = \dfrac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$
• Estimating $p_1 - p_2$ (via a confidence interval) • $n_1 p_1 > 5$, $n_1(1-p_1) > 5$, $n_2 p_2 > 5$, and $n_2(1-p_2) > 5$	$\hat{p}_1 - \hat{p}_2$	$\sqrt{\dfrac{\hat{p}_1(1-\hat{p}_1)}{n_1}+\dfrac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$
• Testing whether $p_1 = p_2$ • $n_1 p_1 > 5$, $n_1(1-p_1) > 5$, $n_2 p_2 > 5$, and $n_2(1-p_2) > 5$	$\hat{p}_1 - \hat{p}_2$	$\sqrt{\hat{p}(1-\hat{p})\left(\dfrac{1}{n_1}+\dfrac{1}{n_2}\right)}$ $\hat{p} = \dfrac{x_1+x_2}{n_1+n_2} = \dfrac{n_1\hat{p}_1+n_2\hat{p}_2}{n_1+n_2}$

Some facts about inference for other parameters

Inference situation	Estimating statistic	Test statistic
• Estimating σ^2 (via a confidence interval) or testing whether σ^2 equals a certain value • Normal populations	s^2	$\dfrac{(n-1)s^2}{\sigma^2}$ follows a chi-square distribution with $n-1$ degrees of freedom
• Estimating $\dfrac{\sigma_1^2}{\sigma_2^2}$ (via a confidence interval) or testing whether $\sigma_1^2 = \sigma_2^2$	$\dfrac{s_1^2}{s_2^2}$	$\dfrac{s_1^2/s_2^2}{\sigma_1^2/\sigma_2^2}$ follows an *F* distribution with n_1-1 numerator degrees of freedom and n_2-1 denominator

- Normal populations | degrees of freedom