Confidence Intervals

Objectives

1. Determine confidence intervals for population mean

2. Determine confidence intervals for population proportion

3. Determine the necessary sample size

How Close Are We to the Population Mean?

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That is where confidence intervals come into play.

How Confident Are We?

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Typical confidence levels are 90%, 95%, 98%, and 99%.

Confidence Interval Setup

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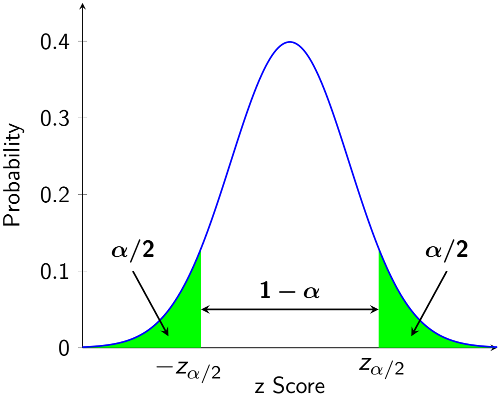
A **point estimate** is a value based on our sample data that represents a reasonable value of the population parameter.

The margin of error is in the form

$$\text{critical value} \times \text{standard error}$$

Critical Values

Critical values are typically in the form $z_{\alpha/2}$ where



Common Critical Values of $z_{\alpha/2}$

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Notice the higher the confidence level, the further away from $z = 0$ the critical value is.

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Note: If σ is unknown, you can use the sample standard deviation, s, when the sample size is large enough ($n \geq 30$).

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A 95% confidence interval for the population mean waiting time is 3.353 to 3.647 minutes.

Error Bars

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However, be advised that some graphs use standard deviation for their error bars.

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A 98% confidence interval for the mean population price per gallon is \$2.41 to \$2.49

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A 98% confidence interval for the mean population price per gallon is \$2.44 to \$2.46

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By doing so, we decrease the width of our confidence interval, while still keeping the confidence level the same.

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- There is a ____ % chance that the population mean is (*whatever the sample mean is*).

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Mean and Standard Error

Our point estimate for a population proportion is $\mu_{\hat{p}} = p$ and the standard error is $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$

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$$p \pm z_{\alpha/2}\sqrt{\frac{p(1-p)}{n}}$$

Example 3

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A 90% confidence interval for the population proportion of voters who favor the renovation is 48.7 to 55.5%

Example 4

The results of a sample of 40 students who took a pass/fail statistics exam are shown below. Construct a 98% confidence interval for the population proportion of students who passed the exam.

Pass	Pass	Fail	Pass	Pass	Pass	Fail	Pass
Fail	Pass	Pass	Pass	Fail	Pass	Pass	Pass
Pass	Fail	Fail	Pass	Pass	Fail	Pass	Pass
Pass	Pass	Fail	Fail	Pass	Pass	Pass	Fail

Example 4

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$$\begin{aligned} & 0.75 \pm 2.326\sqrt{\frac{0.75(0.25)}{40}} \\ &= 0.75 \pm 2.326(0.030) \\ &= 0.75 \pm 0.070 \\ &= (0.68,\ 0.82) \end{aligned}$$

Example 4

$$p = 0.75$$

$$0.75 \pm 2.326\sqrt{\frac{0.75(0.25)}{40}}$$

$$= 0.75 \pm 2.326(0.030)$$

$$= 0.75 \pm 0.070$$

$$= (0.68,\ 0.82)$$

A 98% confidence interval for the population proportion of students who passed the exam is 68 to 82%.

Objectives

1. Determine confidence intervals for population mean
2. Determine confidence intervals for population proportion
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Margin of Error for Population Mean

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$$\sqrt{n} = \frac{\sigma \cdot z_{\alpha/2}}{E}$$

$$n = \left(\frac{\sigma \cdot z_{\alpha/2}}{E}\right)^2$$

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$$n = 138.2976 \to 139$$

We would need a sample of at least 139.

Sample Size for Population Proportion

If we solve

$$E = z_{\alpha/2}\sqrt{\frac{p(1-p)}{n}}$$

for n, we get

$$n = p(1-p)\left(\frac{z_{\alpha/2}}{E}\right)^2$$

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$$n = 0.521(0.479)\left(\frac{1.96}{0.04}\right)^2$$

$$n = 599.191159 \rightarrow 600$$

We would need a sample size of at least 600.