

# 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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So, for our samples, how confident are we that they contain the population mean?

That is where confidence intervals come into play.

# How Confident Are We?

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The **confidence level**, or **level of confidence**, is the percentage of the number of times our confidence intervals will contain the population parameter.

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

# Confidence Interval Setup

A confidence interval for a population parameter is in the form

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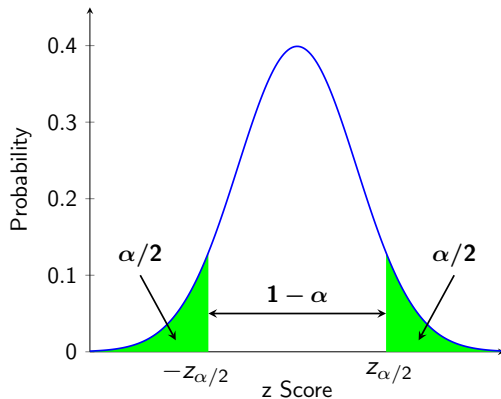
A **point estimate** is a value based on our sample data that represents a reasonable value of the population parameter.

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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*Note:* If  $\sigma$  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 \$2.42 to \$2.48

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Increasing the sample size decreases the standard error.

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

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Our confidence interval for the population proportion is

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

## 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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$$= 0.75 \pm 2.326(0.07)$$

$$= 0.75 \pm 0.159$$

$$= (0.591, 0.909)$$

A 98% confidence interval for the population proportion of students who passed the exam is 59 to 91%.

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

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

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

## Example 5

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$$n = 138.2976 \rightarrow 139$$

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.