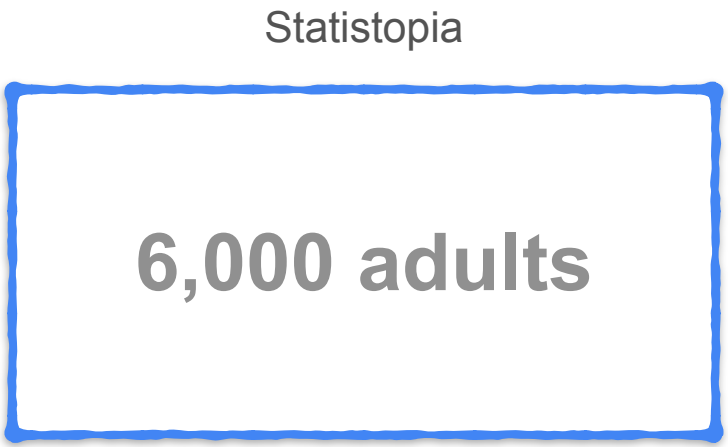
Confidence Interval - Example

Confidence Interval - Example



Confidence Interval - Example

Statistopia

6,000 adults

Random Selection

49

Confidence Interval - Example

Statistopia

6,000 adults

Random Selection

49

$$\bar{x} = 170cm$$

Confidence Interval - Example

Statistopia

6,000 adults

Random Selection

49

$\bar{x} = 170cm$

$\sigma = 25cm$

Confidence Interval - Example

Statistopia

6,000 adults

Random Selection

49

$\bar{x} = 170cm$

$\sigma = 25cm$

Calculate a 95% confidence interval for the average height of adults on Statistopia.

Confidence Interval - Example

Statistopia

6,000 adults

Random Selection

49

$\bar{x} = 170cm$

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

Calculate a 95% confidence interval for the average height of adults on Statistopia.

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

margin of error $=$

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$= 1.96 \cdot \frac{25}{\sqrt{49}}$$

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$= 1.96 \cdot \frac{25}{\sqrt{49}}$$

$$= 1.96 \cdot \frac{25}{7}$$

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$= 1.96 \cdot \frac{25}{\sqrt{49}}$$

$$= 1.96 \cdot \frac{25}{7}$$

$$= 7$$

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$= 1.96 \cdot \frac{25}{\sqrt{49}}$$

$$= 1.96 \cdot \frac{25}{7}$$

$$= 7$$

Confidence Interval - Example

Random Selection

49

$\sigma = 25cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval

$170cm \pm$ margin of error

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$= 1.96 \cdot \frac{25}{\sqrt{49}}$$

$$= 1.96 \cdot \frac{25}{7}$$

$$= 7$$

Confidence Interval - Example

Random Selection

2500

$\sigma = 10cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval

$170cm \pm$ margin of error

margin of error $= 7$

Confidence Interval - Example

Random Selection

2500

$\sigma = 10cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval

$170cm \pm$ margin of error

margin of error $= 7$

Confidence Interval

Confidence Interval - Example

Random Selection

2500

$\sigma = 10cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval

$170cm \pm$ margin of error

margin of error $= 7$

Confidence Interval

$170cm - 7 = 163cm$

Confidence Interval - Example

Random Selection

2500

$\sigma = 10cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval

$170cm \pm$ margin of error

margin of error $= 7$

Confidence Interval

$170cm - 7 = 163cm$

$170cm + 7 = 177cm$

Confidence Interval - Example

Random Selection

2500

$\sigma = 10cm$

95% → $z_{\alpha/2} = 1.96$

Confidence Interval

$170cm \pm$ margin of error

margin of error $= 7$

Confidence Interval

$170cm - 7 = 163cm$

$170cm + 7 = 177cm$

$163cm < \mu < 177cm$

DeepLearning.AI

Confidence Interval

Calculating Sample Size

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Random Selection

49

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Random Selection

49

Margin of error: 7cm

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Random Selection

49

Margin of error: 7cm

$\bar{x} \pm 7cm$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Random Selection

49

Margin of error: 7cm

$\bar{x} \pm 7cm$

$163cm < \mu < 177cm$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Random Selection

49

Margin of error: 7cm

$\bar{x} \pm 7cm$

$163cm < \mu < 177cm$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Random Selection

49

Margin of error: 7cm

$\bar{x} \pm 7cm$

$163cm < \mu < 177cm$

Margin of error: 3 cm

$\bar{x} \pm 3cm$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Random Selection

Margin of error: 7cm

$\bar{x} \pm 7cm$

$163cm < \mu < 177cm$

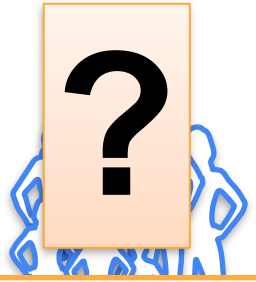
Margin of error: 3 cm

$\bar{x} \pm 3cm$

Calculating Sample Size

6,000 adults

Random Selection



95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm$ σ

What is the smallest sample size to obtain the desired margin of error?

Margin of error: 3 cm

$\bar{x} \pm 3cm$

Margin of error: 7cm

$\bar{x} \pm 7cm$

$163cm < \mu < 177cm$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

3

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$$3 =$$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$$3 = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3$$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 \geq$$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 \geq z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 \geq z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$$3 \geq z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$$3 \geq z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$\bar{x} = 170cm \qquad \sigma = 25cm$

$$3 \geq 1.96 \times \frac{25}{\sqrt{n}}$$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$$3 \geq z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\frac{3}{1.96} \geq \frac{25}{\sqrt{n}}$$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$3 \geq z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{3}{1.96 \times 25} \geq \frac{1}{\sqrt{n}}$$

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$3 \geq z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{1.96 \times 25}{3} \leq \frac{\sqrt{n}}{1}$$

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$$\frac{1.96 \times 25}{3} \leq \frac{\sqrt{n}}{1}$$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\frac{1.96 \times 25}{3} \leq \frac{\sqrt{n}}{1}$$

$$\left(\frac{1.96 \times 25}{3}\right)^2$$

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\frac{1.96 \times 25}{3} \leq \frac{\sqrt{n}}{1}$$

$$\left(\frac{1.96 \times 25}{3}\right)^2 \leq n$$

Calculating Sample Size

6,000 adults

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{1.96 \times 25}{3} \leq \frac{\sqrt{n}}{1}$$

$$n \geq \left(\frac{1.96 \times 25}{3}\right)^2$$

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$$n \geq \left(\frac{1.96 \times 25}{3}\right)^2$$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

Calculating Sample Size

6,000 adults

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

95% → $z_{\alpha/2} = 1.96$

$\bar{x} = 170cm \qquad \sigma = 25cm$

Margin of error: 3 cm

$$n \geq \left(\frac{1.96 \times 25}{3}\right)^2$$

$$n \geq 266.78 \approx 267$$

Calculating Sample Size

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$n \geq \left(\frac{1.96 \times 25}{3}\right)^2$$

Calculating Sample Size

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$n \geq \left(\frac{1.96 \times 25}{3}\right)^2$$

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

DeepLearning.AI

Confidence Interval

Difference Between Confidence and Probability

Difference Between Confidence and Probability

Difference Between Confidence and Probability

$$\bar{x}$$

Difference Between Confidence and Probability

95% Confidence Level

Difference Between Confidence and Probability

95% Confidence Level

The confidence interval contains the true population parameter approximately 95% of the time.

Difference Between Confidence and Probability

95% Confidence Level

The confidence interval contains the true population parameter approximately 95% of the time.

Difference Between Confidence and Probability

95% Confidence Level

The confidence interval contains the true population parameter approximately 95% of the time.

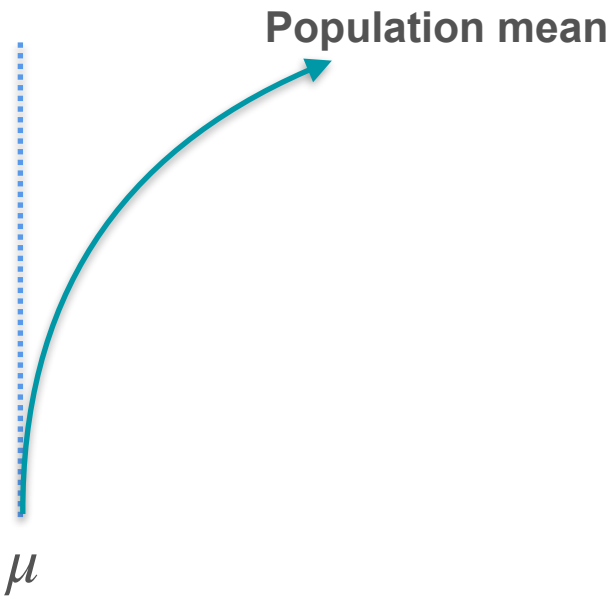
There's a 95% probability that the population parameter falls within the confidence interval.

Difference Between Confidence and Probability

95% Confidence Level

Difference Between Confidence and Probability

95% Confidence Level

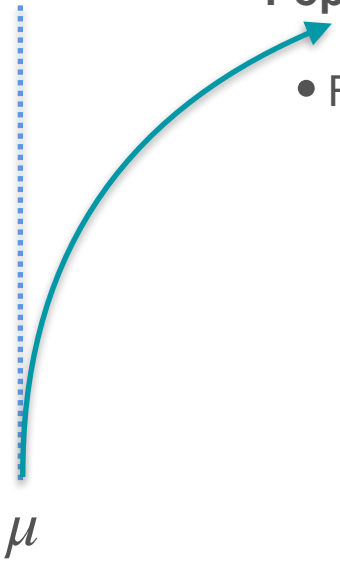


Difference Between Confidence and Probability

95% Confidence Level

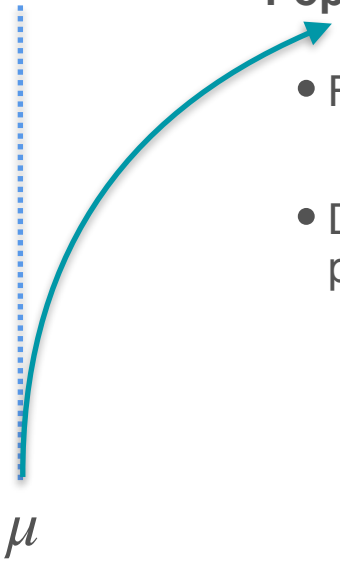
Population mean

- Fixed but unknown



Difference Between Confidence and Probability

95% Confidence Level



Population mean

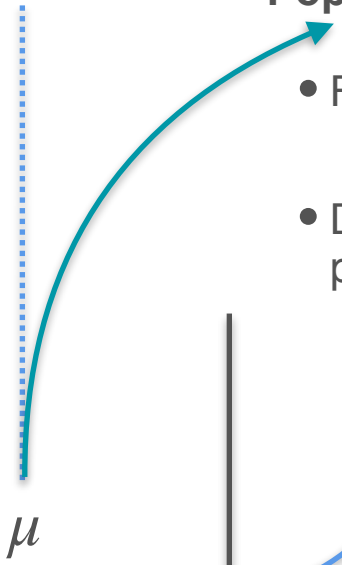
- Fixed but unknown
- Does not have a probability distribution

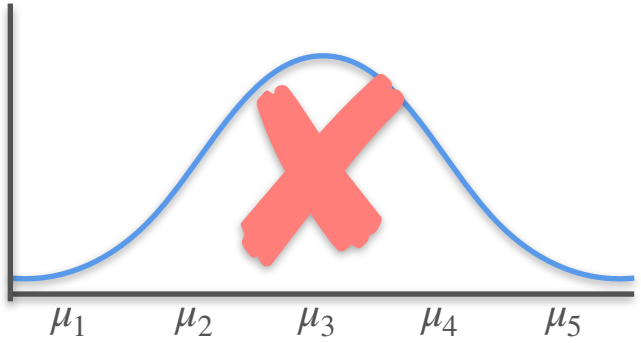
Difference Between Confidence and Probability

95% Confidence Level

Population mean

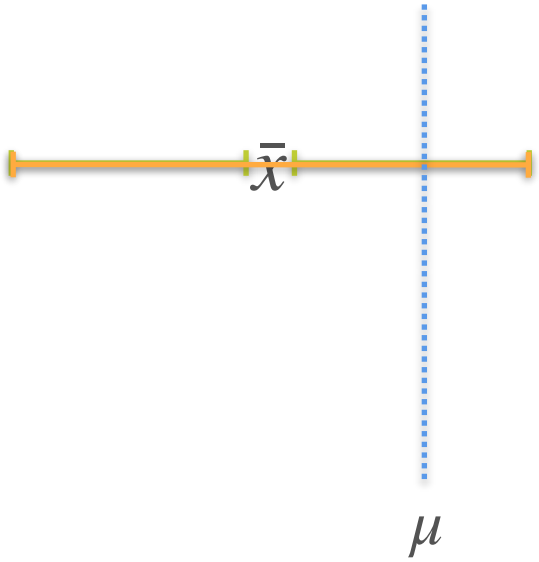
- Fixed but unknown
- Does not have a probability distribution





Difference Between Confidence and Probability

95% Confidence Level

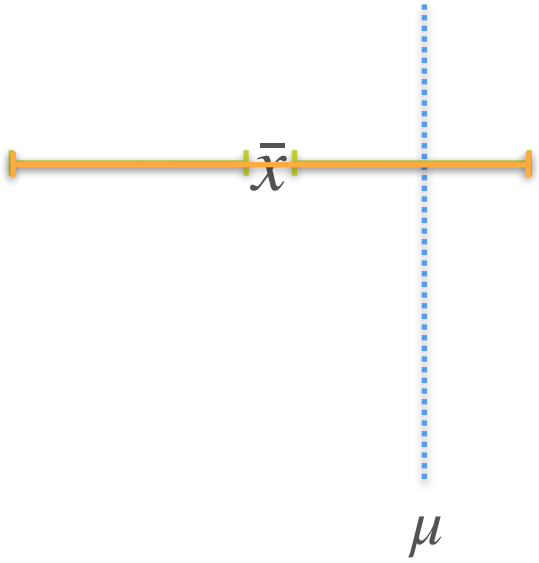


Population mean

- Fixed but unknown
- Does not have a probability distribution
- In the interval

Difference Between Confidence and Probability

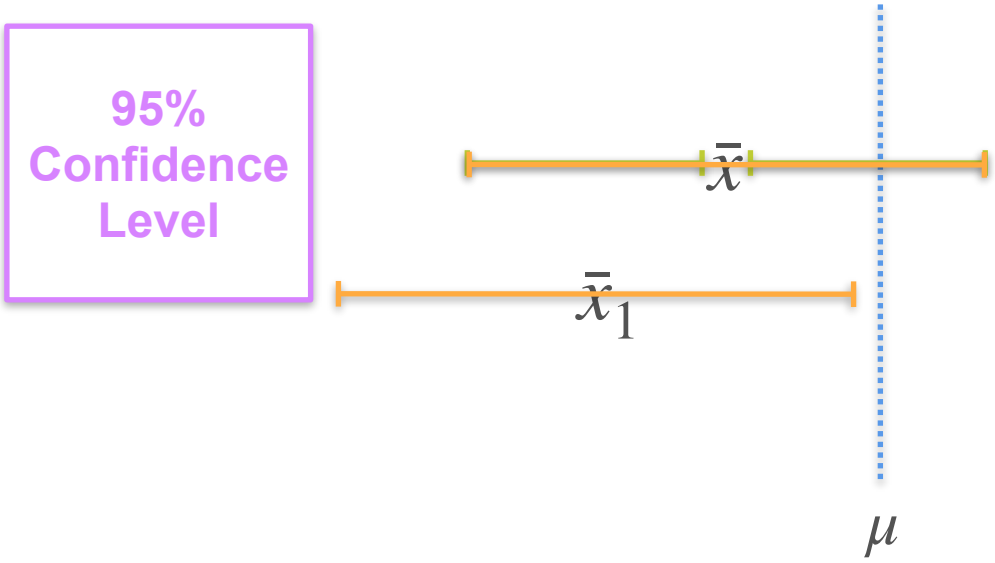
95% Confidence Level



Population mean

- Fixed but unknown
- Does not have a probability distribution
- In the interval or not

Difference Between Confidence and Probability

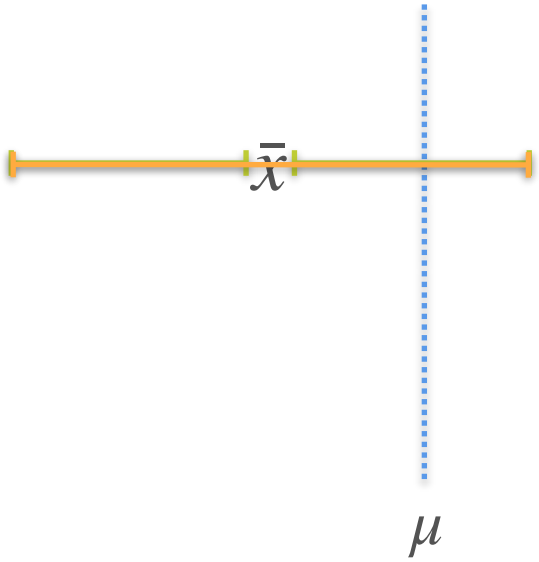


Population mean

- Fixed but unknown
- Does not have a probability distribution
- In the interval or not

Difference Between Confidence and Probability

95% Confidence Level

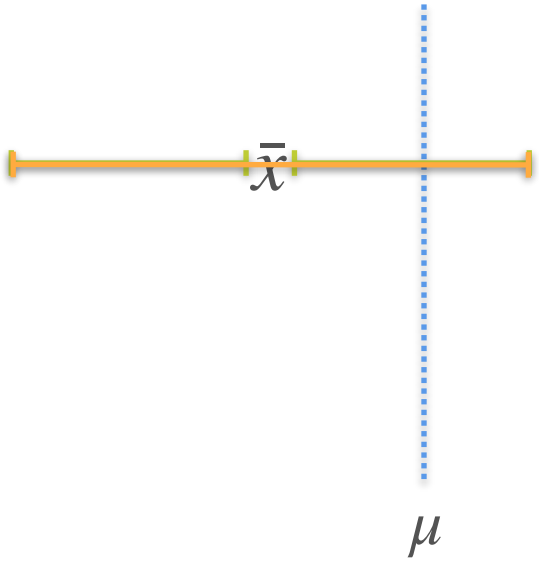


Population mean

- Fixed but unknown
- Does not have a probability distribution
- In the interval or not
- Does not fall within a specific interval 95% of the time

Difference Between Confidence and Probability

95% Confidence Level



Population mean

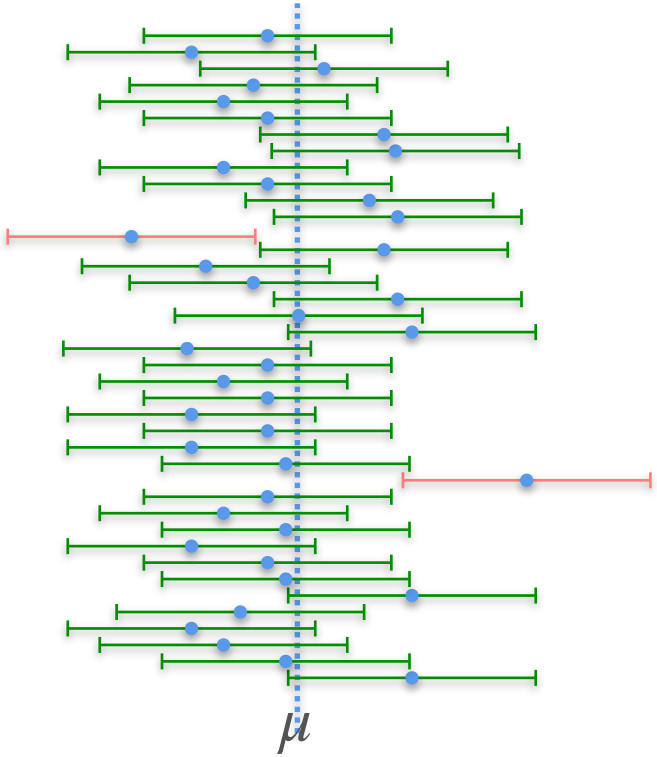
- Fixed but unknown
- Does not have a probability distribution
- In the interval or not
- Does not fall within a specific interval 95% of the time

Difference Between Confidence and Probability

95% Confidence Level

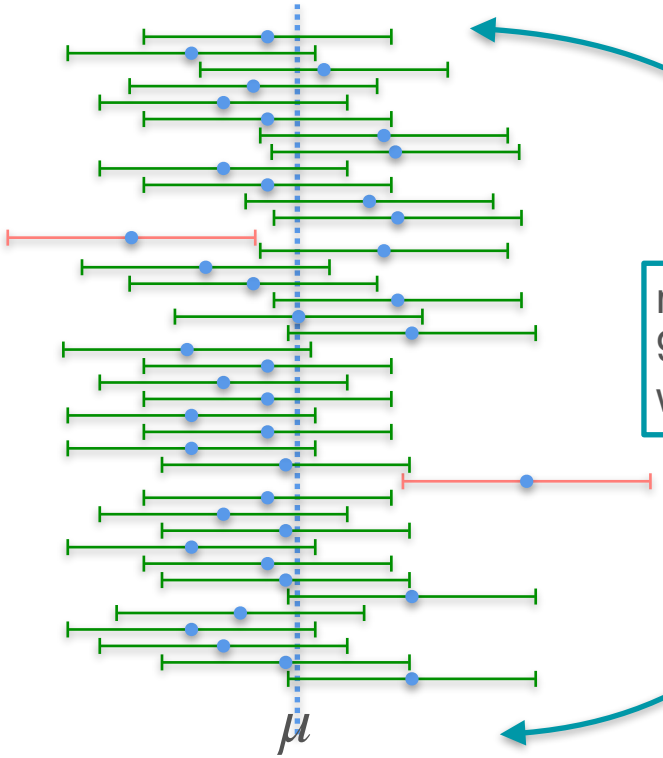
Difference Between Confidence and Probability

95% Confidence Level



Difference Between Confidence and Probability

95% Confidence Level

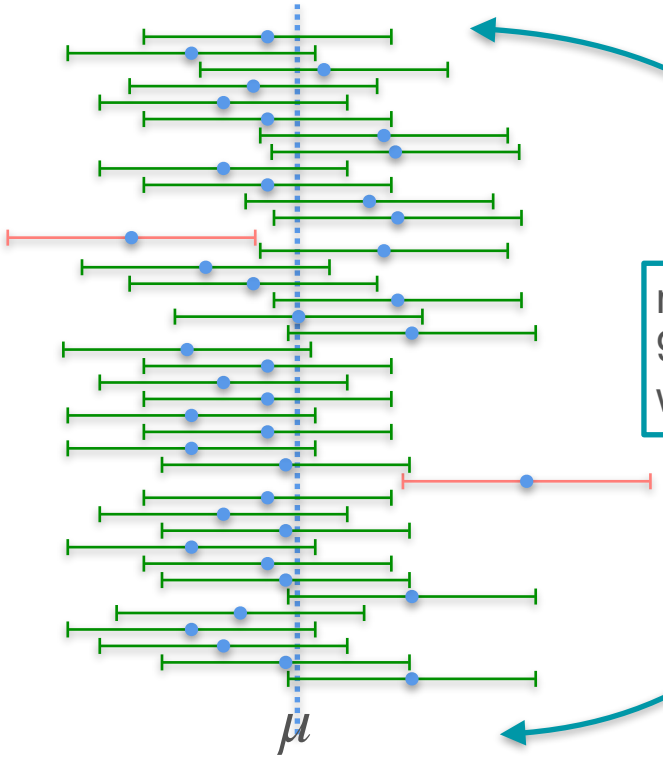


repeated many times, 95% of these intervals will contain μ

Difference Between Confidence and Probability

95% Confidence Level

success rate for constructing the confidence interval

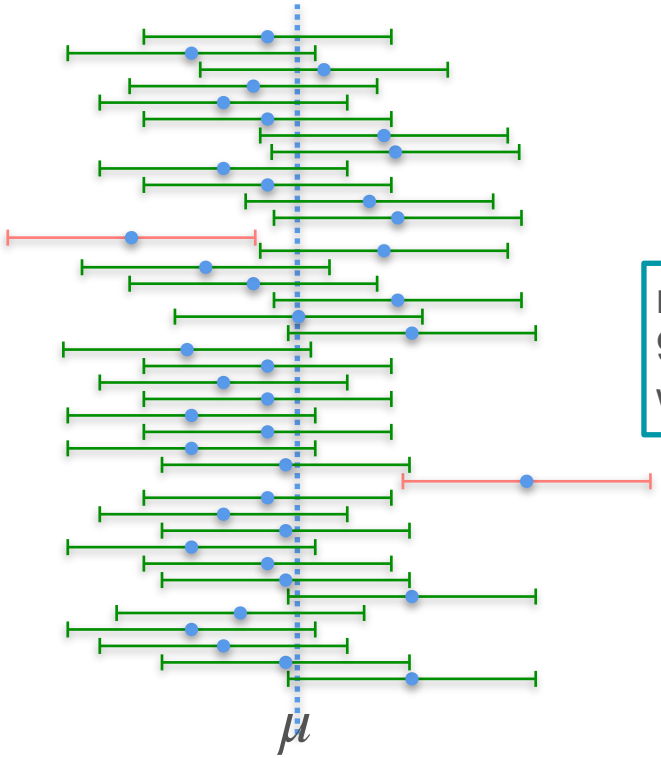


repeated many times, 95% of these intervals will contain μ

Difference Between Confidence and Probability

95% Confidence Level

success rate for constructing the confidence interval

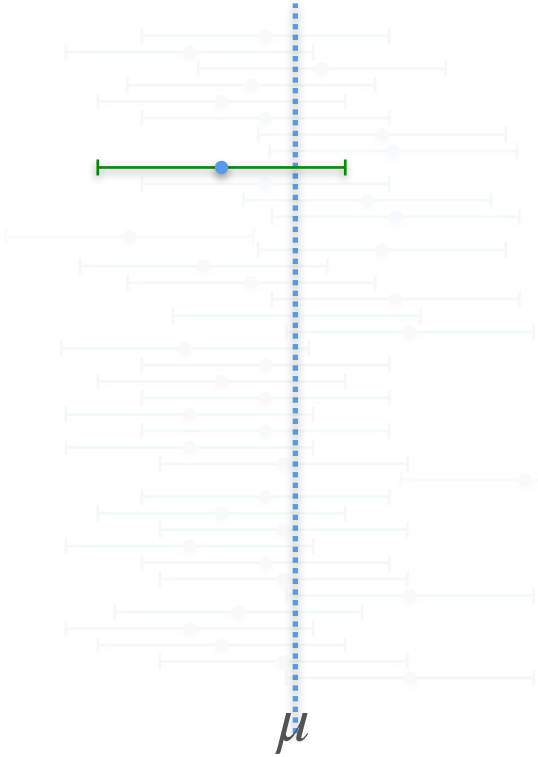


repeated many times, 95% of these intervals will contain μ

Difference Between Confidence and Probability

95% Confidence Level

success rate for constructing the confidence interval

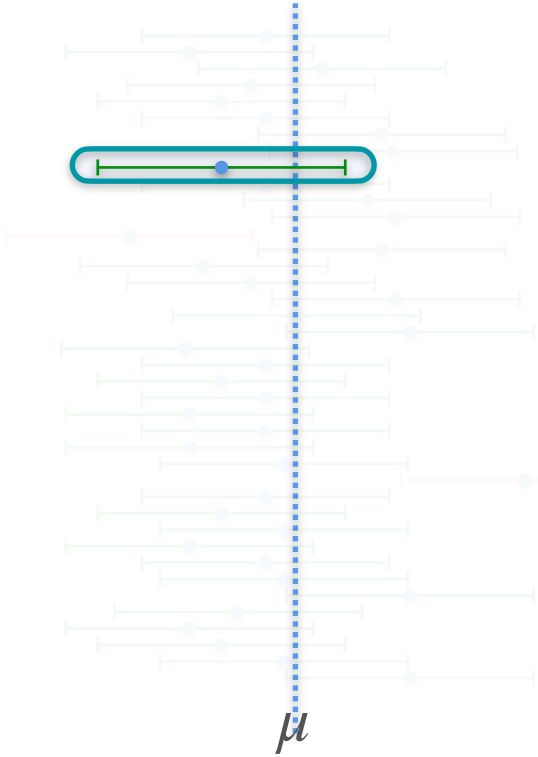


repeated many times, 95% of these intervals will contain μ

Difference Between Confidence and Probability

95% Confidence Level

success rate for constructing the confidence interval



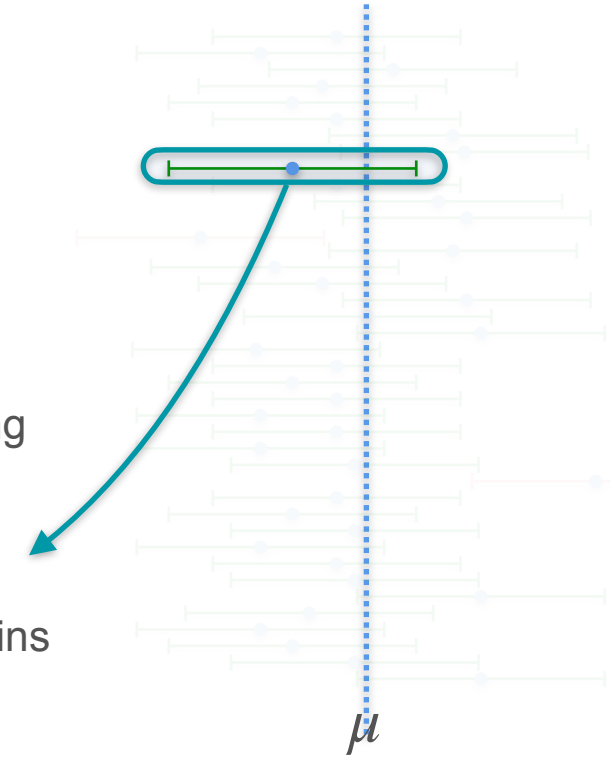
repeated many times, 95% of these intervals will contain μ

Difference Between Confidence and Probability

95% Confidence Level

success rate for constructing the confidence interval

not the probability that one specific intervals contains the population mean



repeated many times, 95% of these intervals will contain μ

DeepLearning.AI

Confidence Interval

Confidence Interval (Unknown Standard Deviation)

Confidence Interval - t Distribution

Confidence Interval - t Distribution

$$\bar{x} \pm z_{\alpha/2} \bullet \frac{\sigma}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \bullet \frac{\sigma}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution

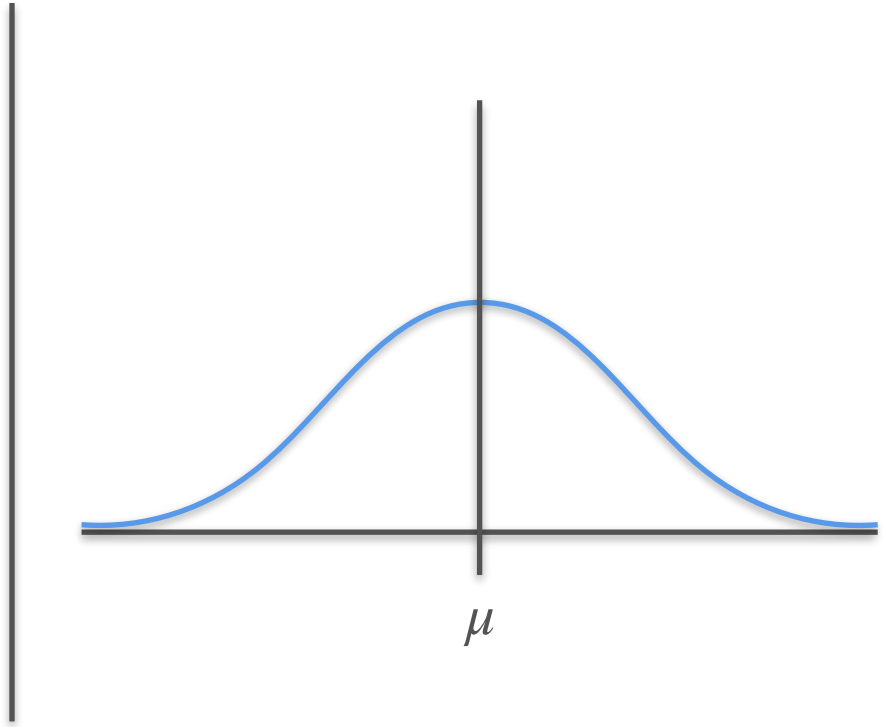
Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution



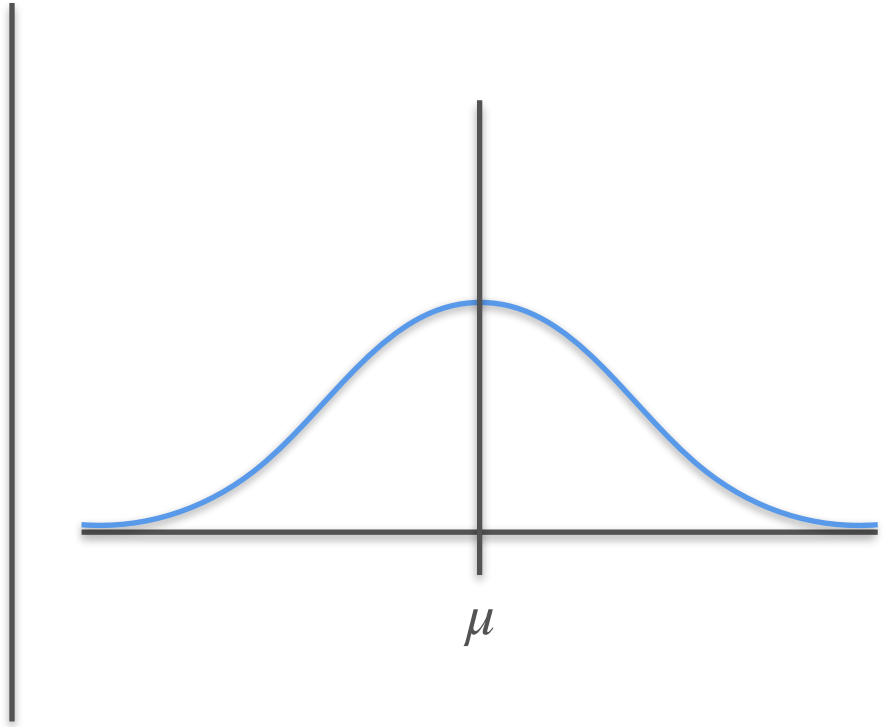
Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution



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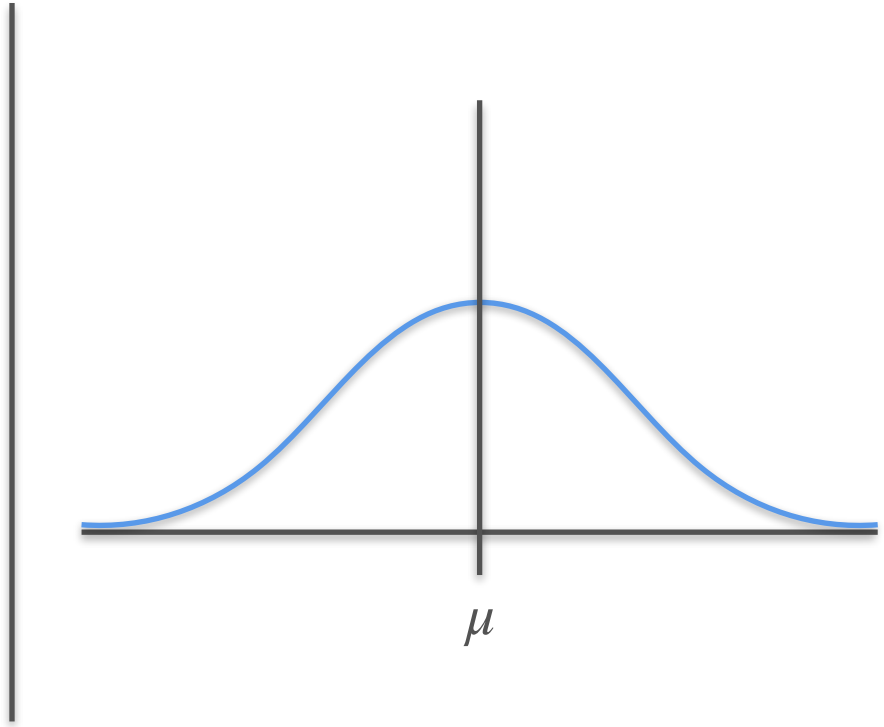

Confidence Interval - t Distribution

known σ ?

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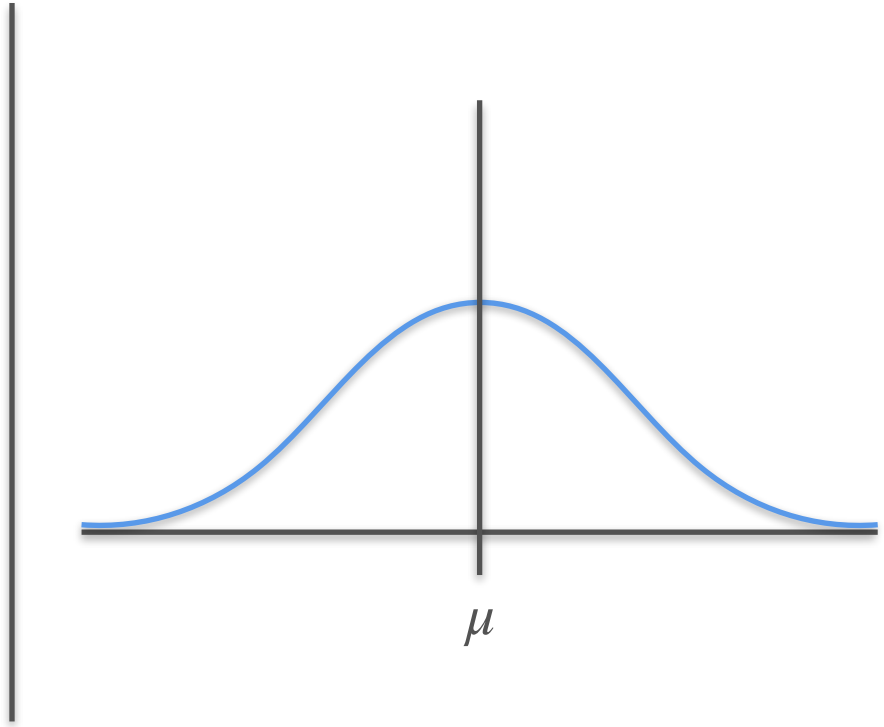
$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution



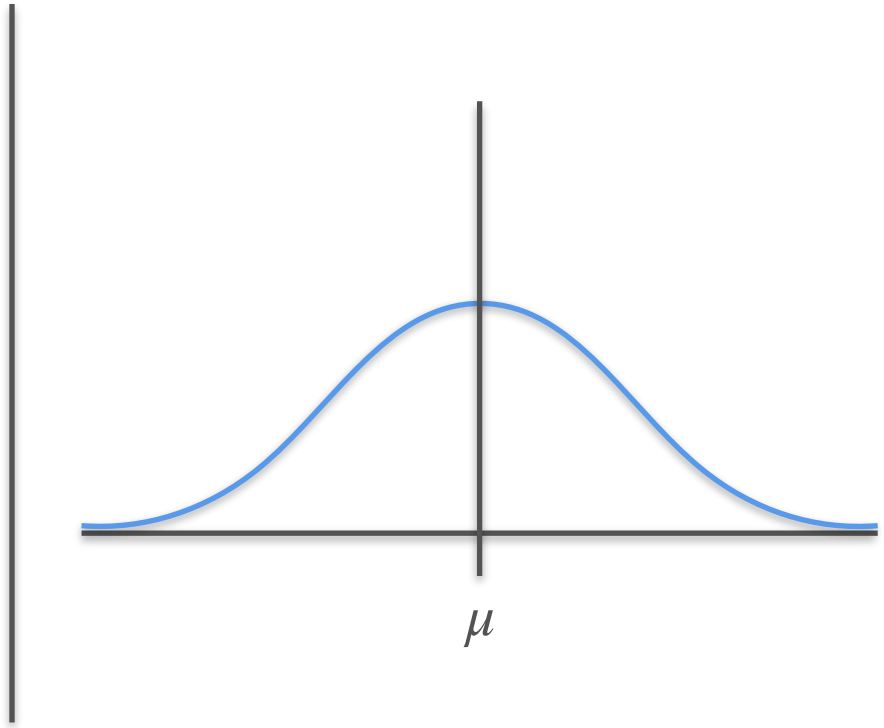
Confidence Interval - t Distribution

known σ ? $\rightarrow$ s

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution



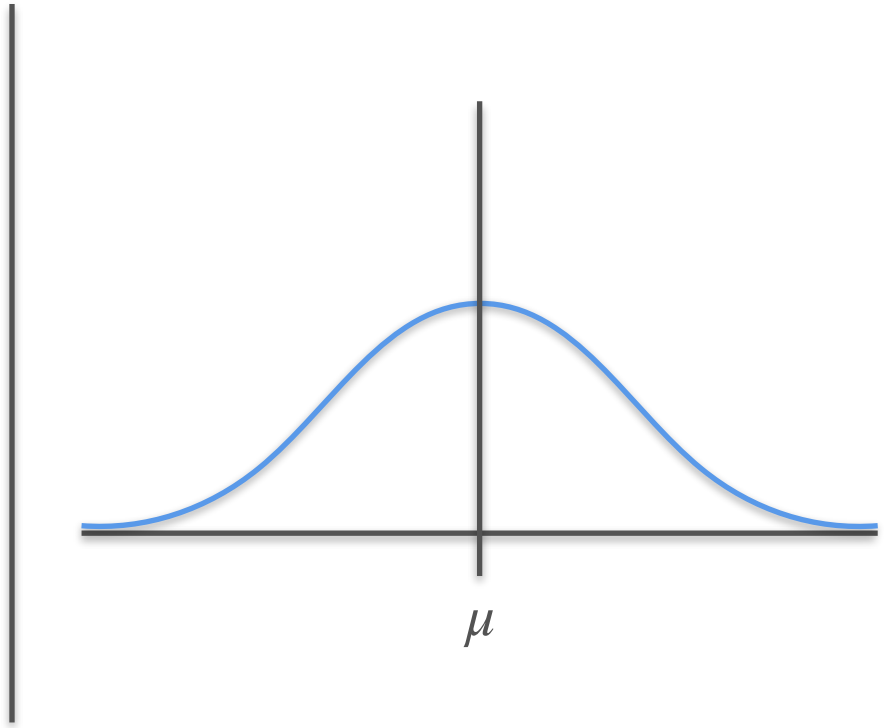
Confidence Interval - t Distribution

known σ ? $\rightarrow$ s

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \dashrightarrow \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

normal distribution



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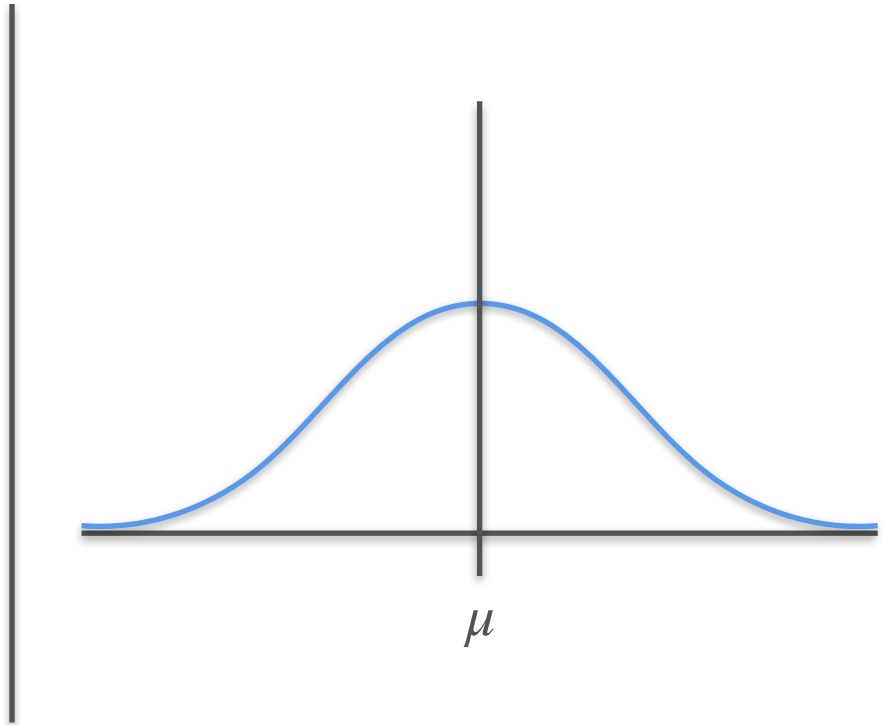
normal distribution

not a normal distribution



Confidence Interval - t Distribution

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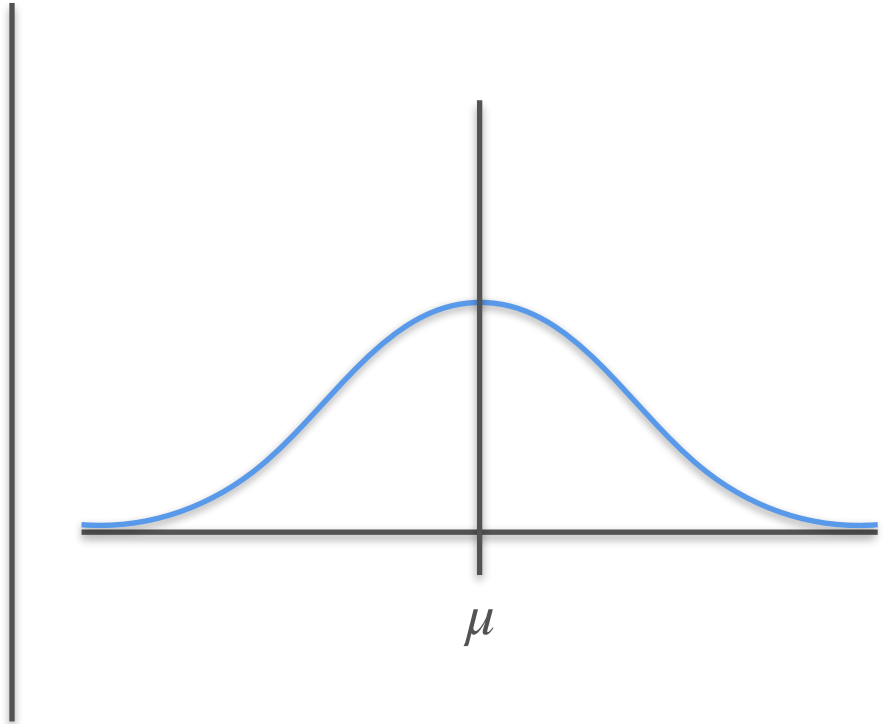
$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \dashrightarrow \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

normal distribution

not a normal distribution

student's t distribution



Confidence Interval - t Distribution

known σ ? $\rightarrow$ s

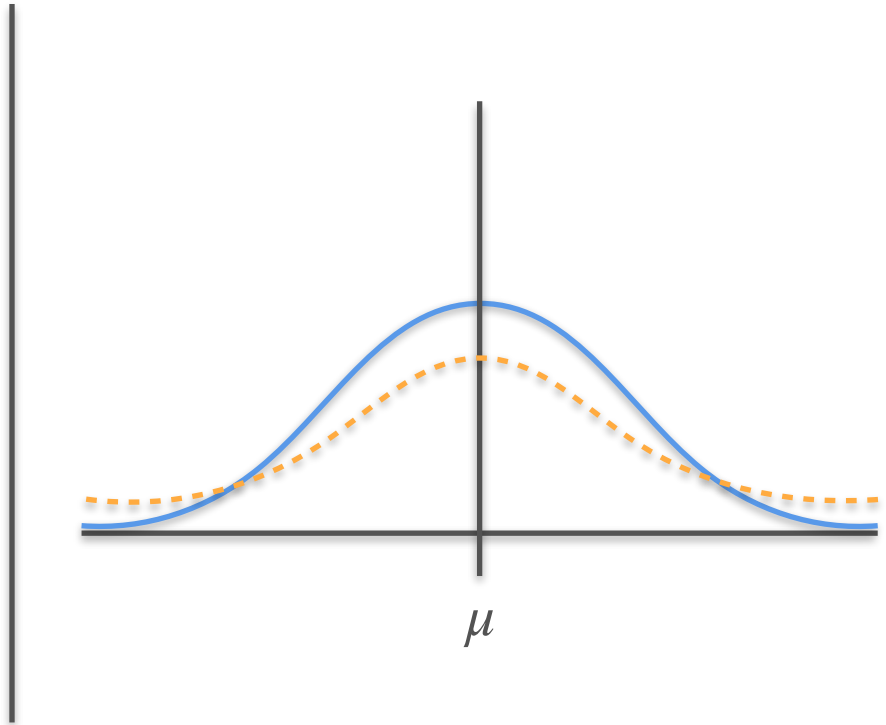
$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \qquad \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

normal distribution

not a normal distribution

student's t distribution



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normal distribution

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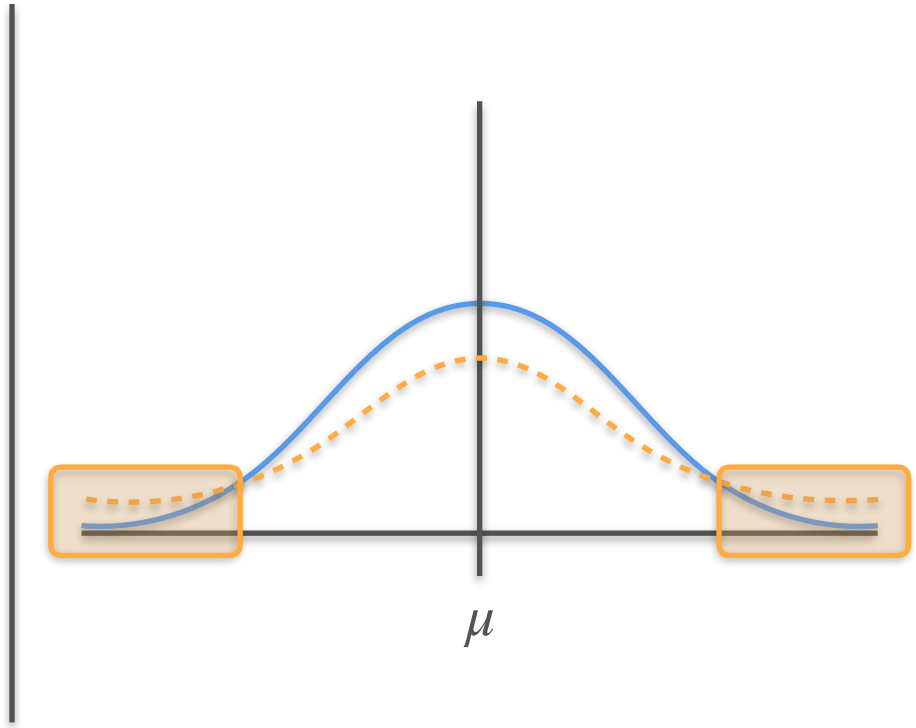
student's t distribution



Confidence Interval - t Distribution

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normal distribution

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Confidence Interval - t Distribution

known σ

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

unknown σ ⋯▶ replace with s

Confidence Interval - t Distribution

known σ

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normal distribution

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Confidence Interval - t Distribution

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normal distribution

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unknown σ ⇢ replace with s

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \dashrightarrow \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

Confidence Interval - t Distribution

known σ

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

unknown σ ⋯▶ replace with s

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \dashrightarrow \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

student's t distribution

Confidence Interval - t Distribution

known σ

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

unknown σ ⋯▸ replace with s

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \cdots\cdots\blacktriangleright \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

student's t distribution

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

normal distribution

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unknown σ ⋯▸ replace with s

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \cdots\cdots\blacktriangleright \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

student's t distribution

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

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unknown σ ⋯▸ replace with s

$$\frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \cdots\cdots\blacktriangleright \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

student's t distribution

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

unknown σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

unknown σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

unknown σ

$$\bar{x} \pm z_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

known σ

$$\bar{x} \pm z_{\alpha/2} \bullet \frac{\sigma}{\sqrt{n}}$$

unknown σ

$$\bar{x} \pm t_{\alpha/2} \bullet \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

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unknown σ

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unknown σ

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Confidence Interval - t Distribution

unknown σ

$$\bar{x} \pm t_{\alpha/2} \bullet \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

unknown σ

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

Confidence Interval - t Distribution

unknown σ

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

degrees of freedom

Confidence Interval - t Distribution

unknown σ

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

degrees of freedom

$$n - 1$$

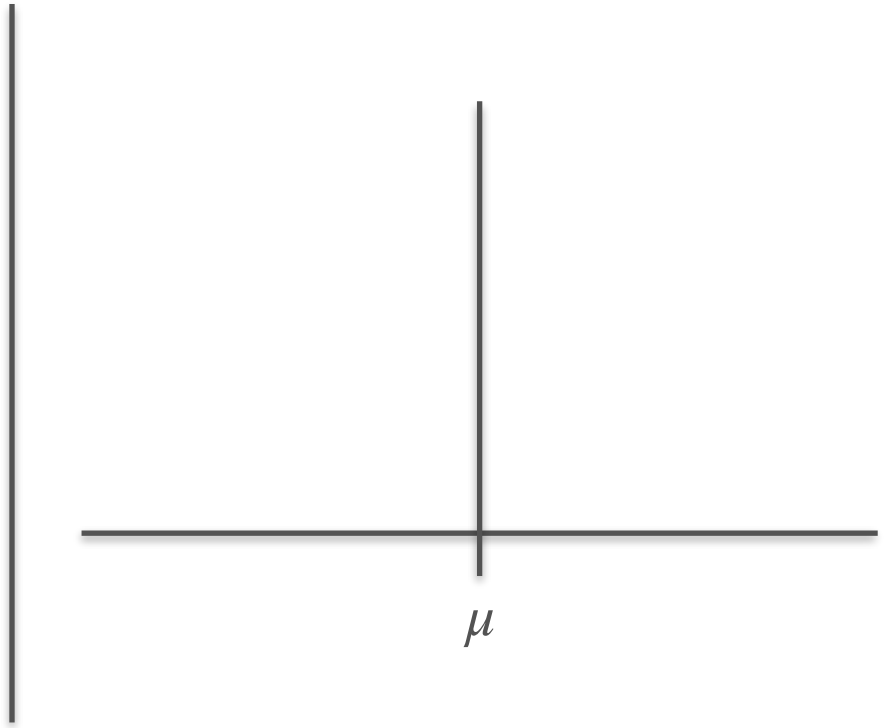
Confidence Interval - t Distribution

unknown σ

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

degrees of freedom

$$n - 1$$



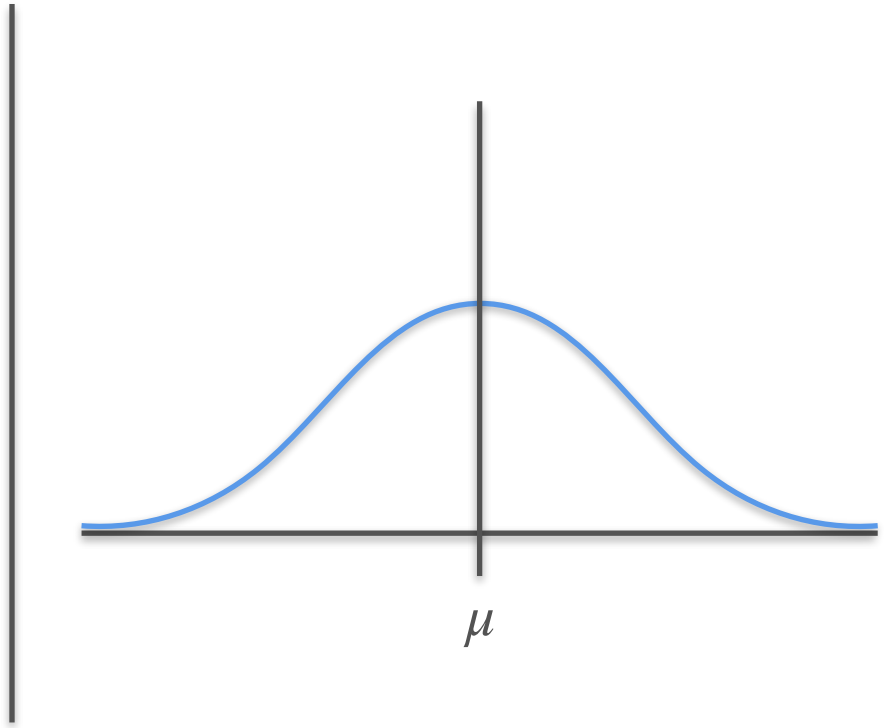
Confidence Interval - t Distribution

unknown σ

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

degrees of freedom

$$n - 1$$



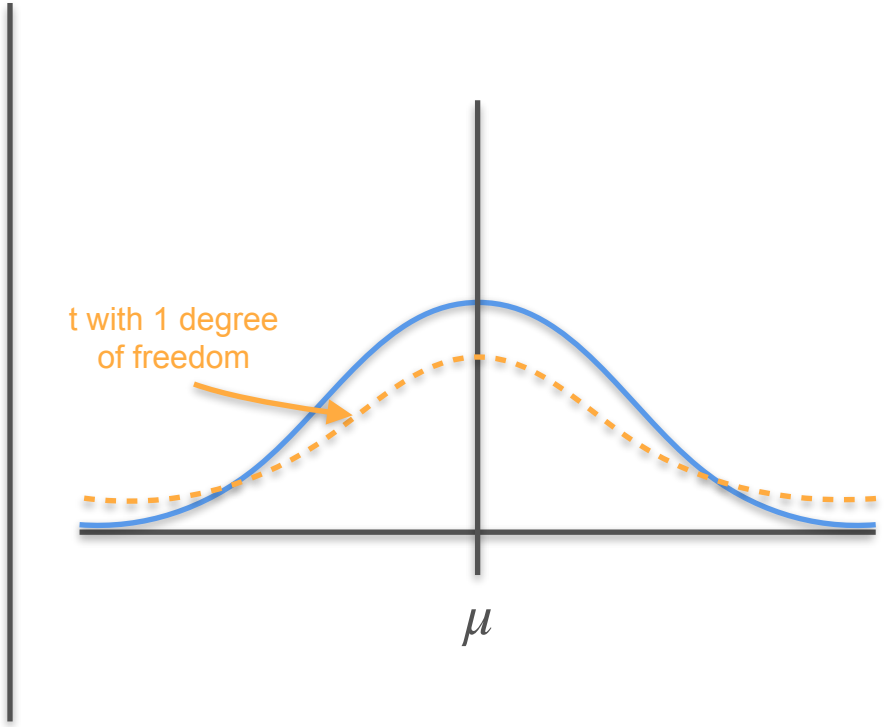
Confidence Interval - t Distribution

unknown σ

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}}$$

degrees of freedom

$$n - 1$$



Confidence Interval - t Distribution

unknown σ

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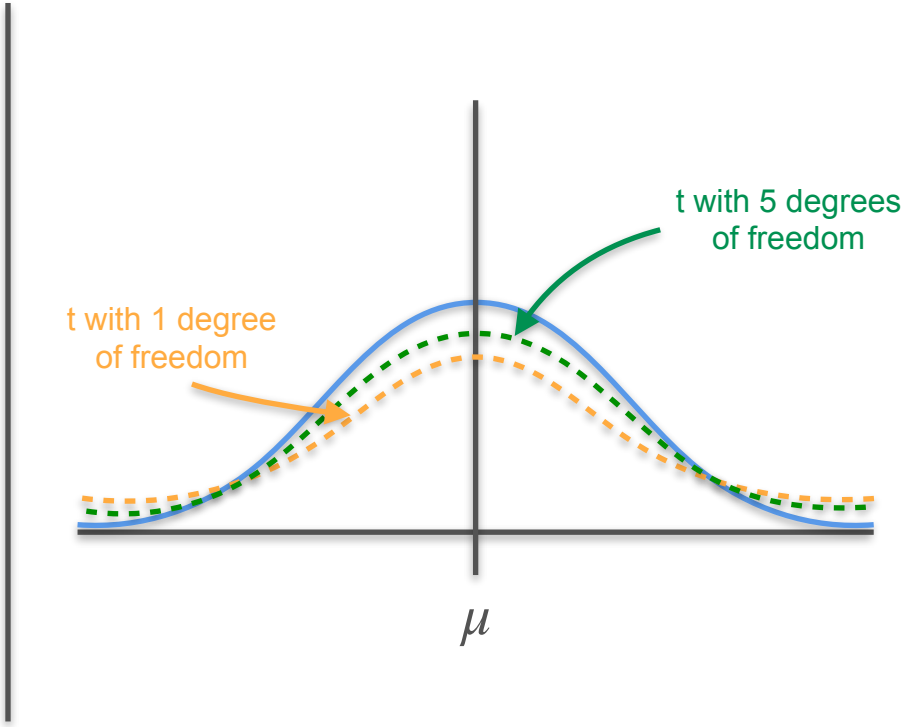
degrees of freedom

$$n - 1$$



Confidence Interval - t Distribution

unknown σ

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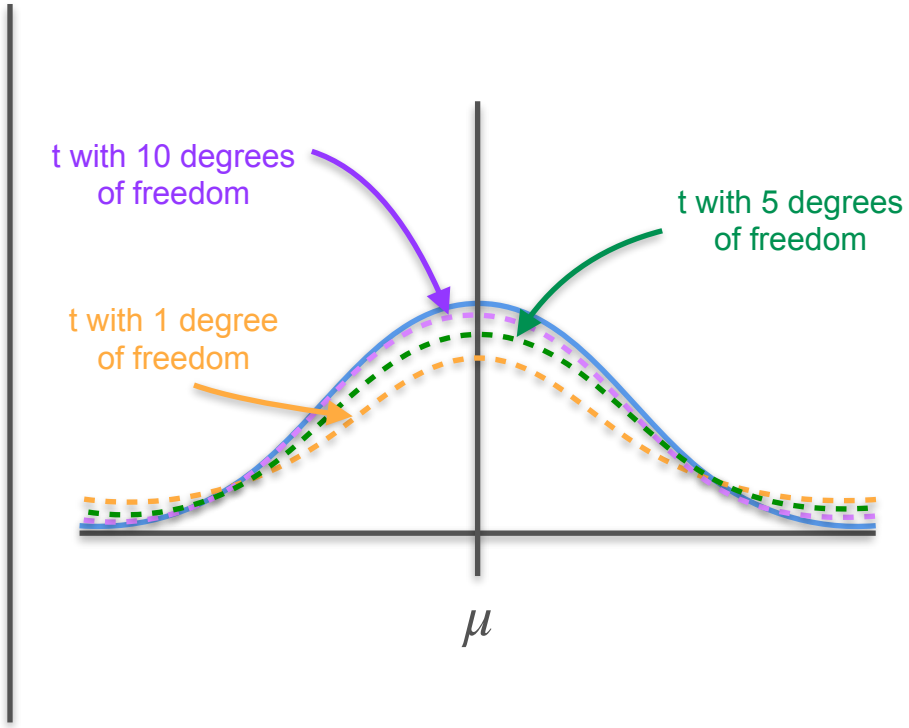
degrees of freedom

$$n - 1$$



DeepLearning.AI

Confidence Interval

Confidence Intervals for Proportion

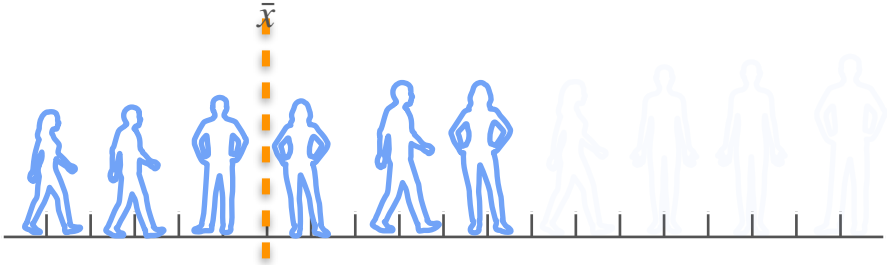
Confidence Interval for Proportions

Confidence Interval for Proportions

Confidence Interval for Means

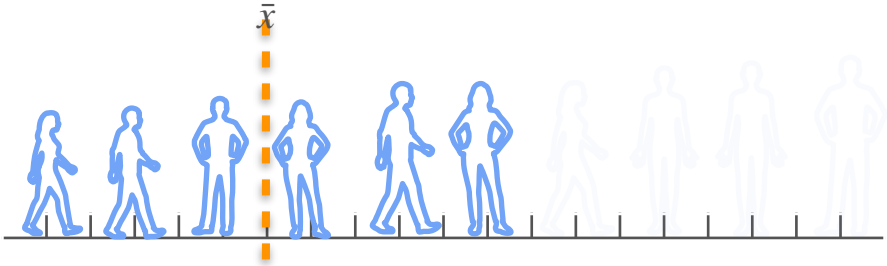
Confidence Interval for Proportions

Confidence Interval for Means



Confidence Interval for Proportions

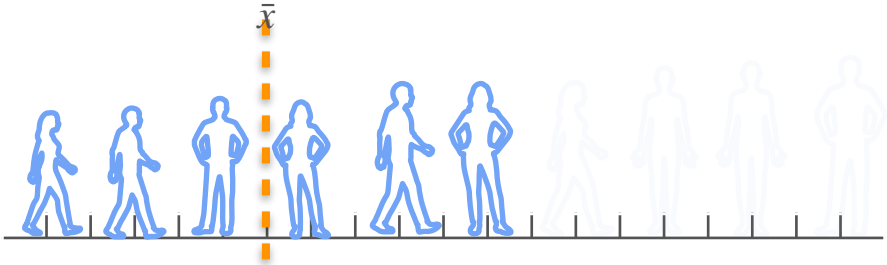
Confidence Interval for Means



confidence interval $= \bar{x} \pm$ margin of error

Confidence Interval for Proportions

Confidence Interval for Means

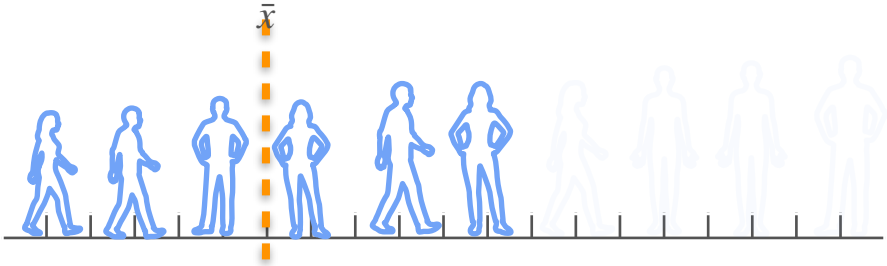


confidence interval $=$ $\bar{x} \pm$ margin of error

margin of error $=$

Confidence Interval for Proportions

Confidence Interval for Means

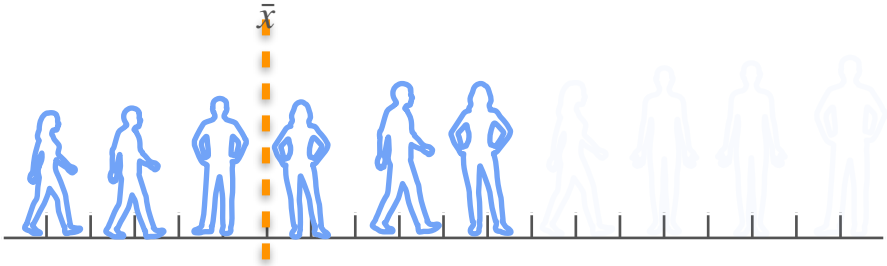


$$\text{confidence interval} = \bar{x} \pm \text{margin of error}$$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

Confidence Interval for Proportions

Confidence Interval for Means



$$\text{confidence interval} = \bar{x} \pm \text{margin of error}$$

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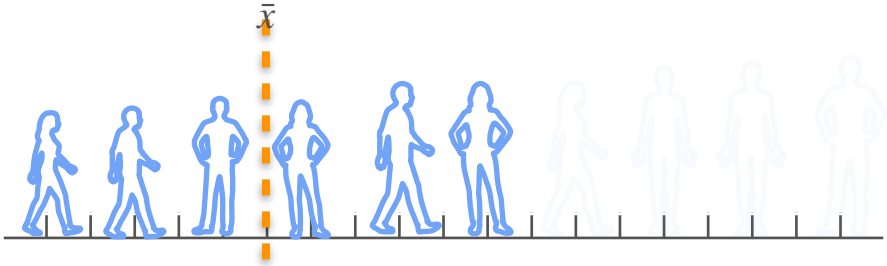
Confidence Interval for Proportions

Confidence Interval for Means



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Confidence Interval for Proportions

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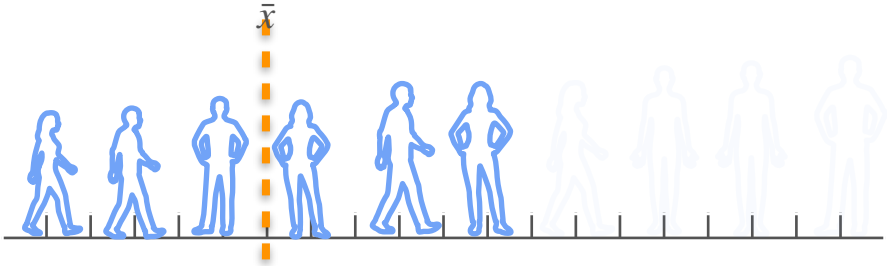

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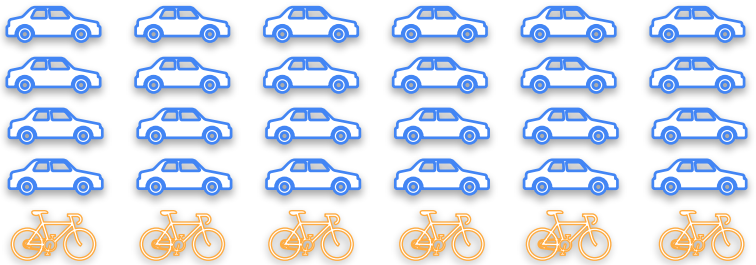
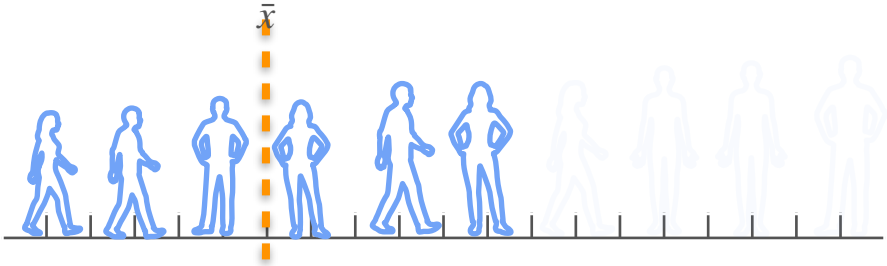


Confidence Interval for Proportions

Confidence Interval for Means



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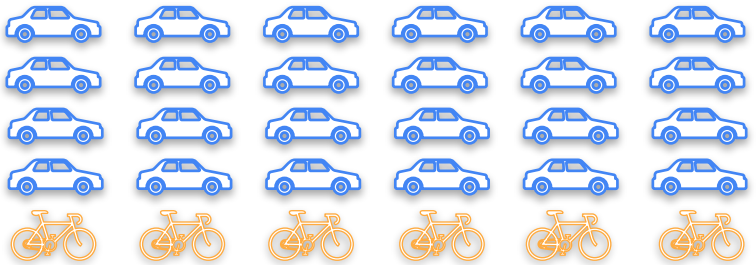
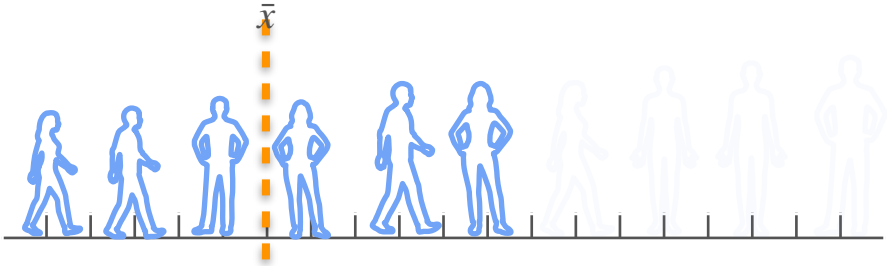


$$n = 30$$

Confidence Interval for Proportions

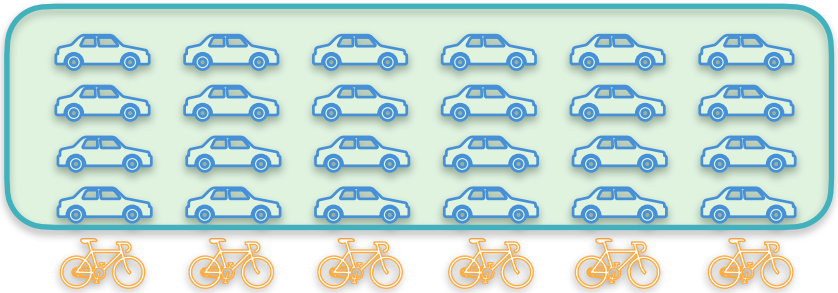
Confidence Interval for Means



$$\text{confidence interval} = \bar{x} \pm \text{margin of error}$$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

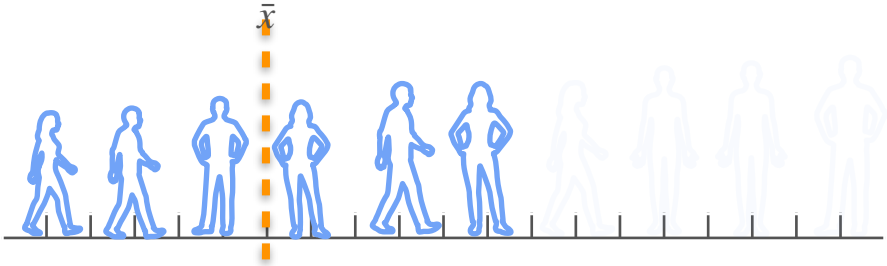
Confidence Interval for Proportions



$$n = 30$$

Confidence Interval for Proportions

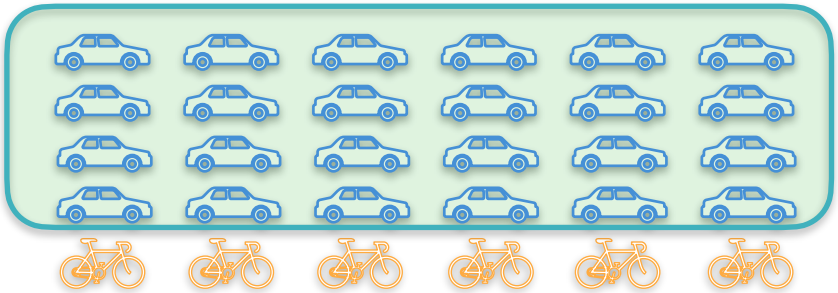
Confidence Interval for Means



$$\text{confidence interval} = \bar{x} \pm \text{margin of error}$$

$$\text{margin of error} = z_{\alpha/2} \bullet \frac{\sigma}{\sqrt{n}}$$

Confidence Interval for Proportions

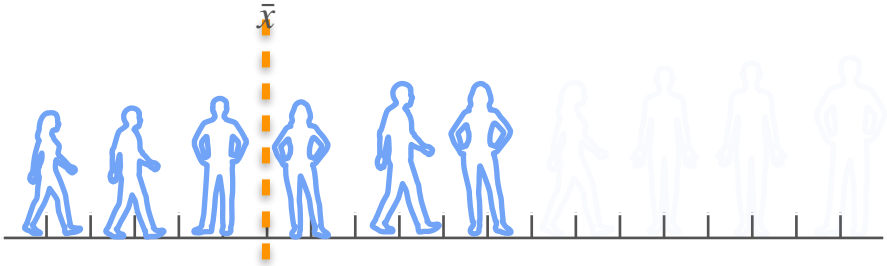


$$x = 24$$

$$n = 30$$

Confidence Interval for Proportions

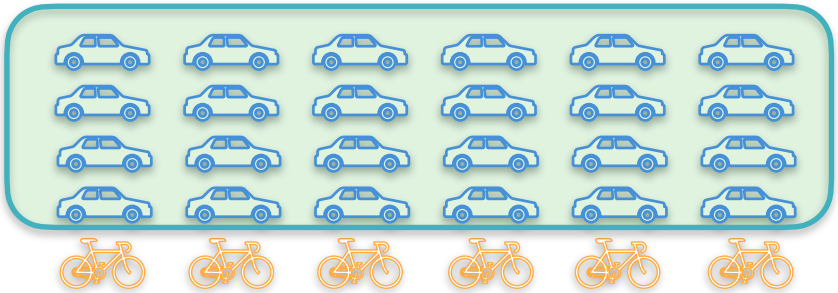
Confidence Interval for Means



$$\text{confidence interval} = \bar{x} \pm \text{margin of error}$$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

Confidence Interval for Proportions



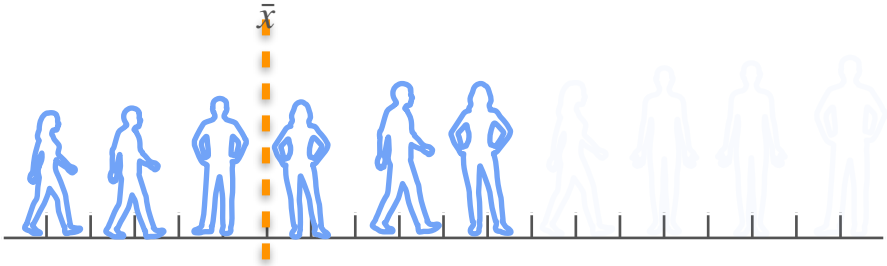
$$x = 24$$

$$n = 30$$

$$\hat{p} = \frac{x}{n} = \frac{24}{30} = 80\,\%$$

Confidence Interval for Proportions

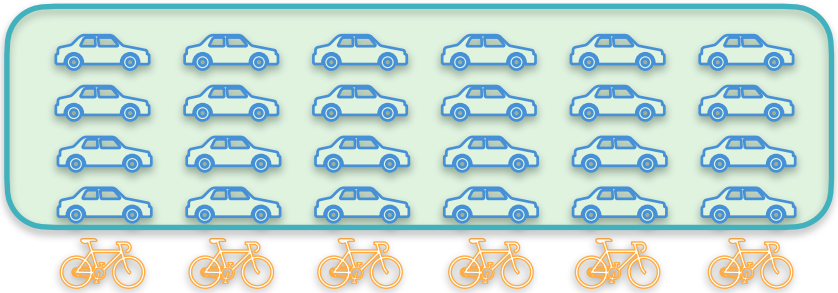
Confidence Interval for Means



$$\text{confidence interval} = \bar{x} \pm \text{margin of error}$$

$$\text{margin of error} = z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

Confidence Interval for Proportions



$$x = 24$$

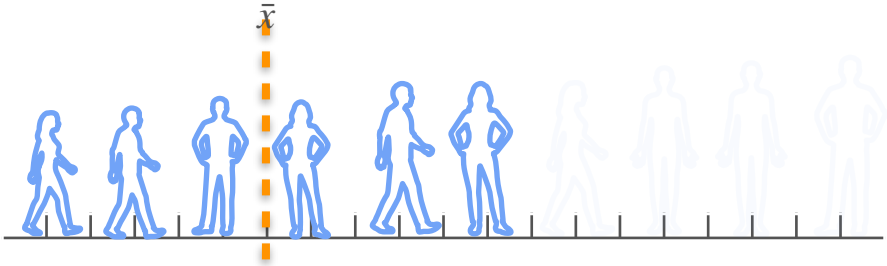
$$n = 30$$

$$\hat{p} = \frac{x}{n} = \frac{24}{30} = 80\,\%$$

How do you calculate a 95% confidence interval for this sample proportion?

Confidence Interval for Proportions

Confidence Interval for Means



$$\text{confidence interval} = \bar{x} \pm \text{margin of error}$$

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Confidence Interval for Proportions

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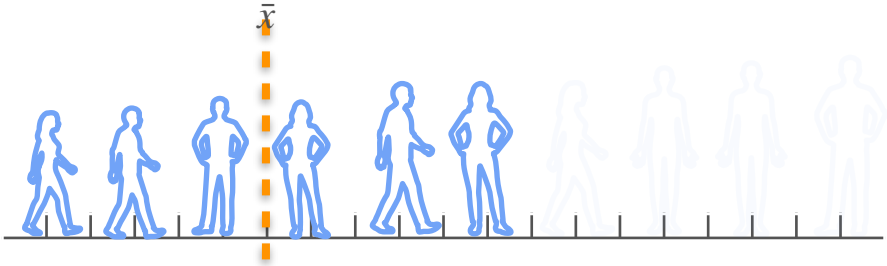
Confidence Interval for Proportions

Confidence Interval for Means



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Confidence Interval for Proportions

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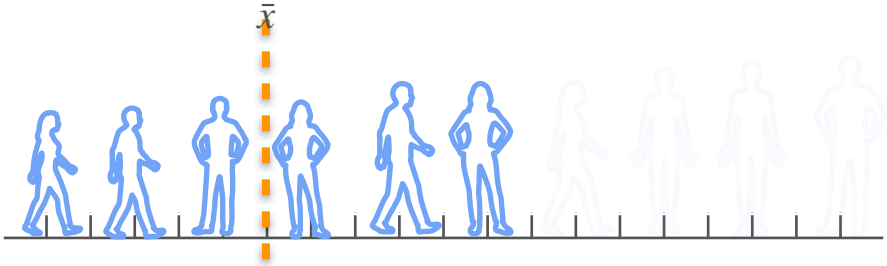
$$\text{confidence interval} =$$

Confidence Interval for Proportions

Confidence Interval for Means



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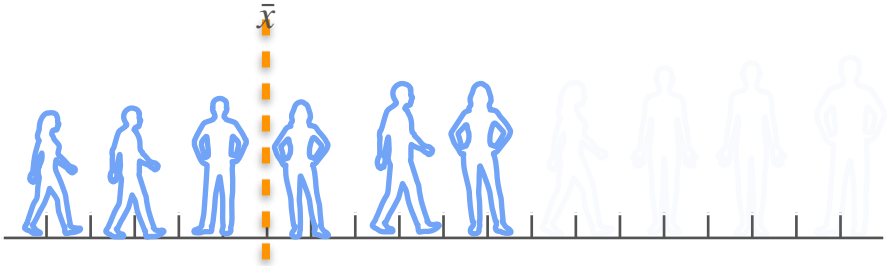
Confidence Interval for Proportions

Confidence Interval for Means



confidence interval $=$ $\bar{x} \pm$ margin of error

margin of error $=$ $z_{\alpha/2} \bullet \frac{\sigma}{\sqrt{n}}$

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Confidence Interval for Proportions

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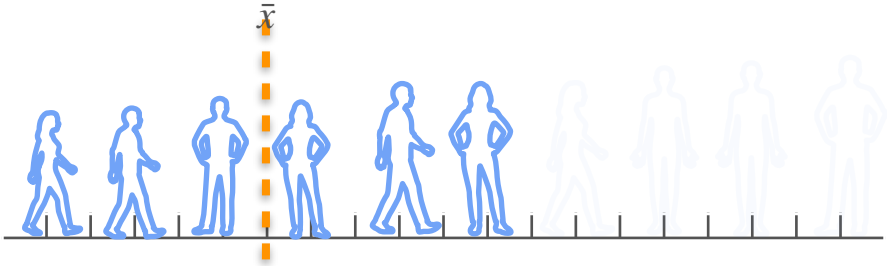

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margin of error $=$

Confidence Interval for Proportions

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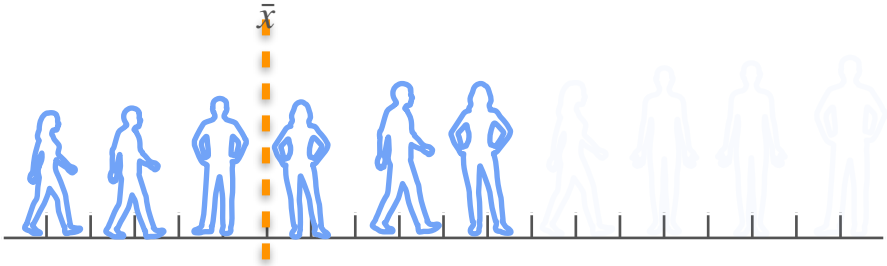

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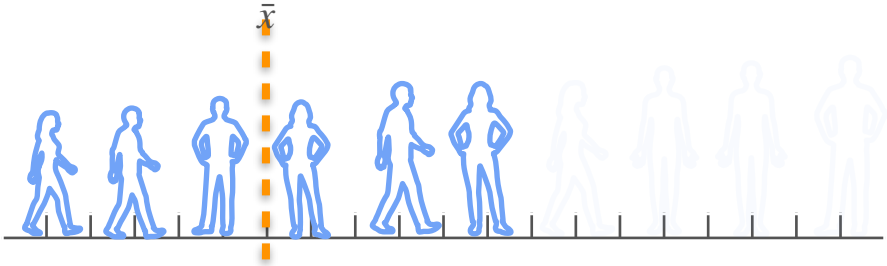
Confidence Interval for Proportions

Confidence Interval for Means



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Confidence Interval for Proportions

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$$\text{confidence interval} = \hat{p} \pm \text{margin of error}$$

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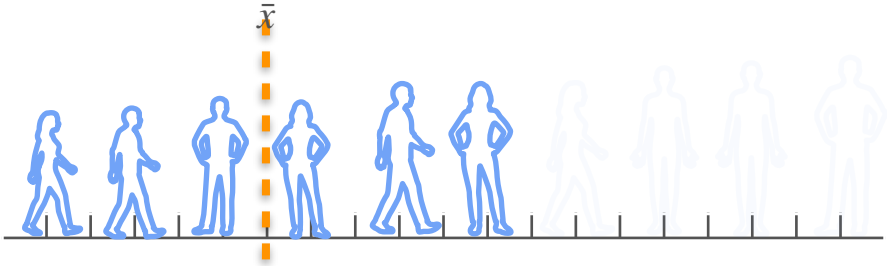
Confidence Interval for Proportions

Confidence Interval for Means



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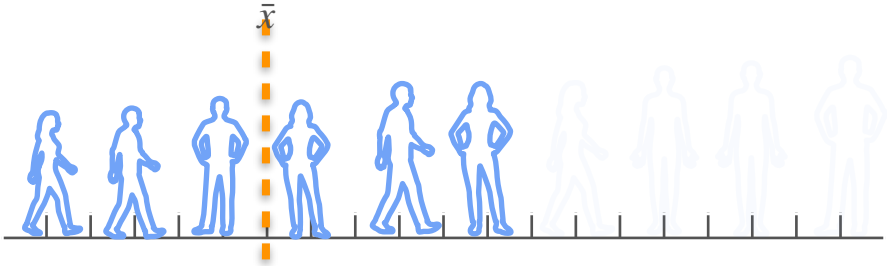
Confidence Interval for Means



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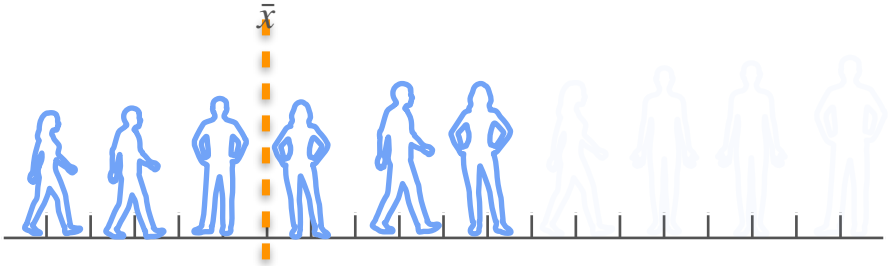

confidence interval $= \bar{x} \pm$ margin of error

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confidence interval $= \hat{p} \pm$ margin of error

margin of error $= z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

standard error

Confidence Interval for Proportions

Confidence Interval for Proportions

Confidence Interval for Proportions

Confidence Interval for Proportions

confidence interval =

Confidence Interval for Proportions

Confidence Interval for Proportions

confidence interval $= \hat{p}$

Confidence Interval for Proportions

Confidence Interval for Proportions

confidence interval $= \hat{p} \pm$ margin of error

Confidence Interval for Proportions

Confidence Interval for Proportions

confidence interval $= \hat{p} \pm$ margin of error

margin of error $=$

Confidence Interval for Proportions

Confidence Interval for Proportions

confidence interval $= \hat{p} \pm$ margin of error

margin of error $= z_{\alpha/2} \bullet$

Confidence Interval for Proportions

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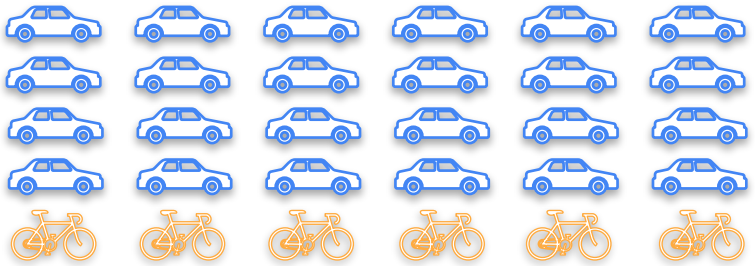

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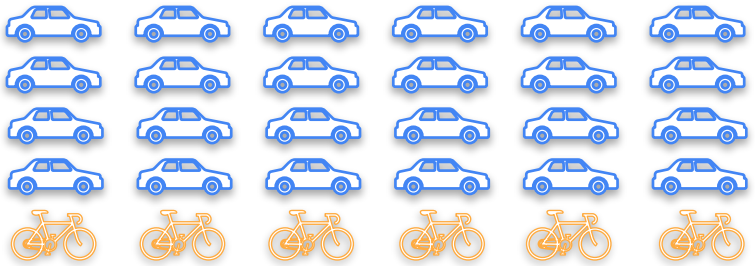

$n = 30$

Confidence Interval for Proportions

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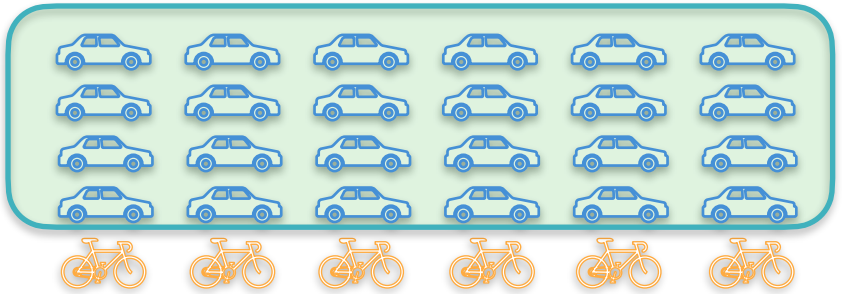

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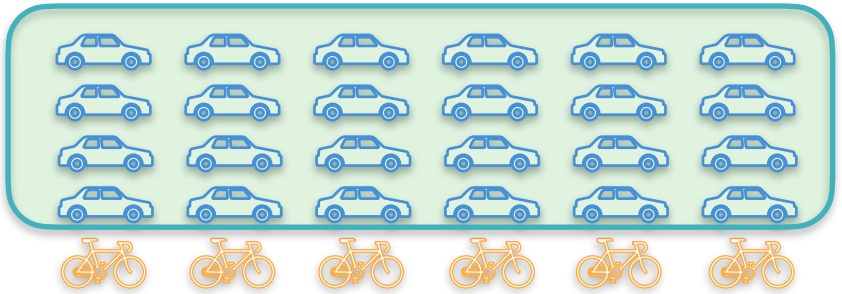

$n = 30$ $\hat{p} = 80\,\% = 0.8$

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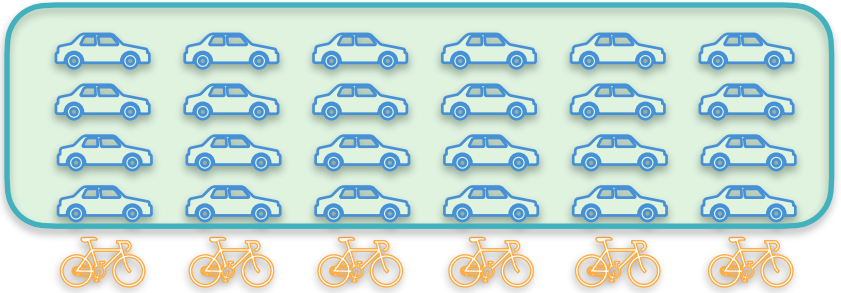

$n = 30$ $\hat{p} = 80\% = 0.8$

Calculate a 95% confidence interval for this sample proportion

Confidence Interval for Proportions

Confidence Interval for Proportions

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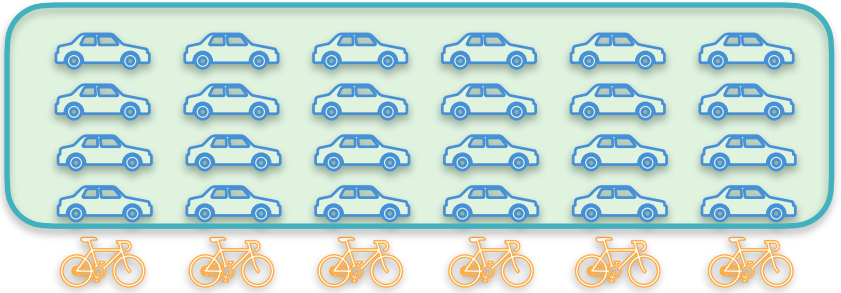
$$\text{margin of error} = z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$



$n = 30$ $\hat{p} = 80\,\% = 0.8$

Calculate a 95% confidence interval for this sample proportion

95% → $z_{\alpha/2} = 1.96$

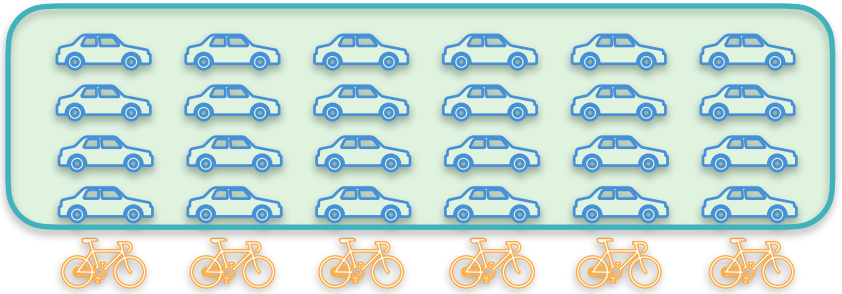
Confidence Interval for Proportions

Confidence Interval for Proportions

confidence interval $=$ $\hat{p} \pm$ margin of error

margin of error $= z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

margin of error $=$



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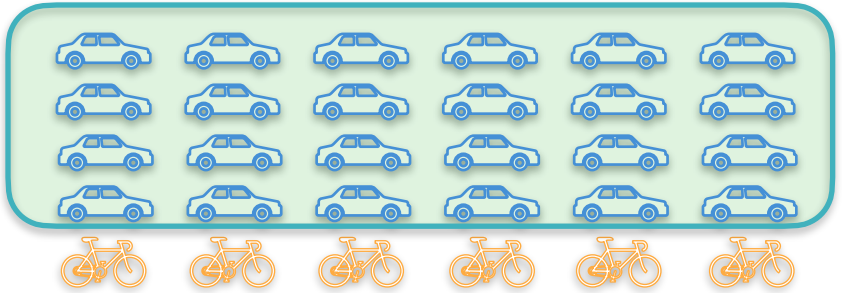

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Confidence Interval for Proportions

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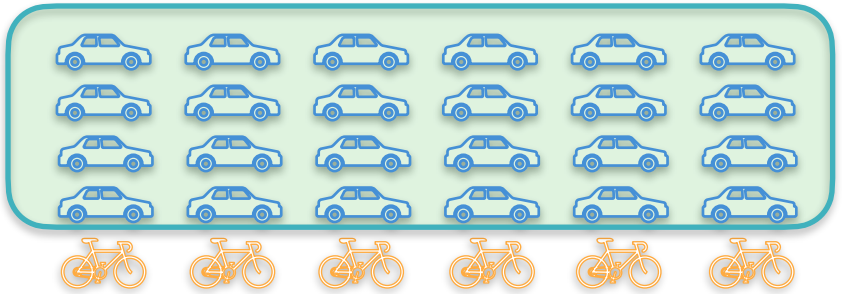
$$\text{margin of error} = 1.96 \cdot \sqrt{\frac{0.8(1-0.8)}{30}}$$



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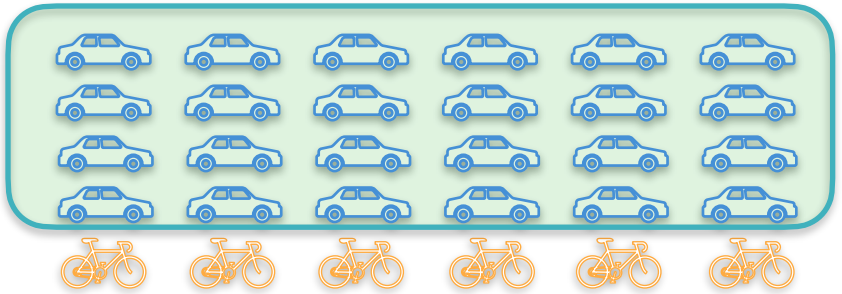
$$\text{margin of error} = 0.14$$



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Confidence Interval for Proportions

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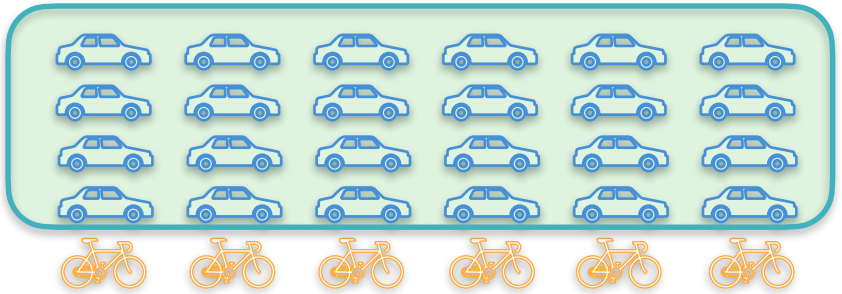

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Confidence Interval for Proportions

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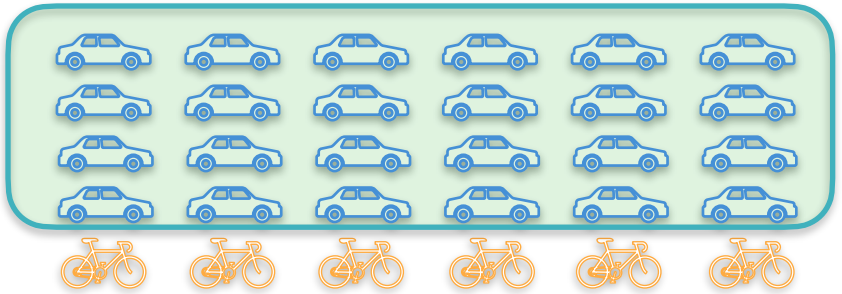
margin of error $= 0.14$

confidence interval $=$



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Confidence Interval for Proportions

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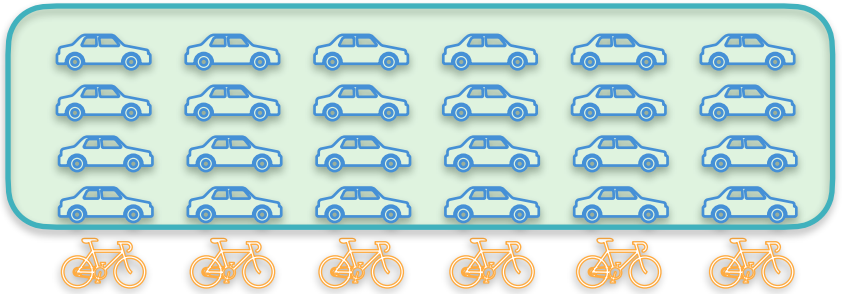
margin of error $= 0.14$

confidence interval $= 0.8 \pm 0.14$



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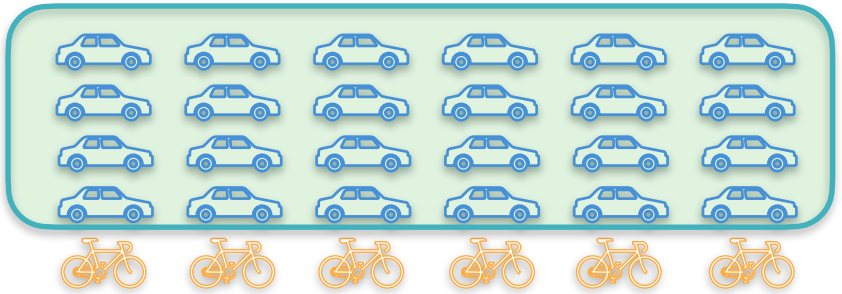
margin of error $= 0.14$

confidence interval $= 0.8 \pm 0.14$

$$0.66 < p < 0.94$$



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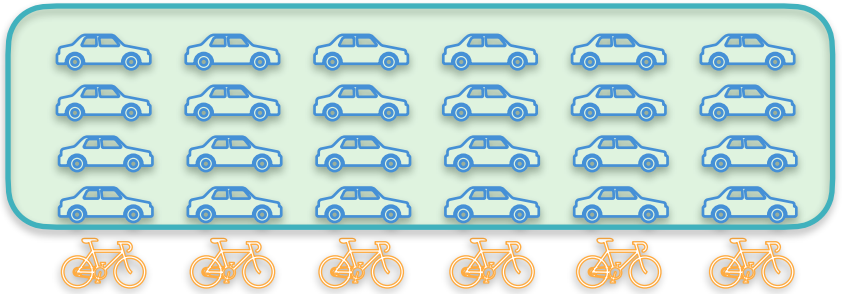
$$0.66 < p < 0.94$$

$$66\% < p < 94\%$$



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Calculate a 95% confidence interval for this sample proportion

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W4 Lesson 2

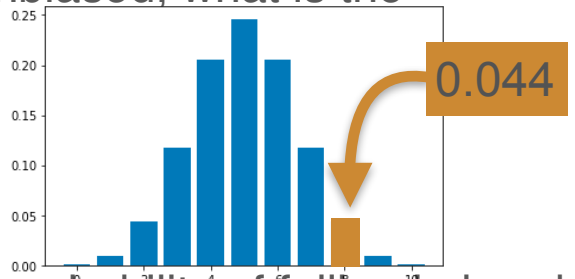
Hypothesis Testing

- Data Science interview
  - I throw a coin 10 times. I get heads 8 times.
  - Quiz 1: Do you think the coin is biased, or not?
    - Keep both answers correct. Specify that we don't have enough information.
  - More information: We agree to say that something is *unlikely* if the probability of it happening is less than 5%.

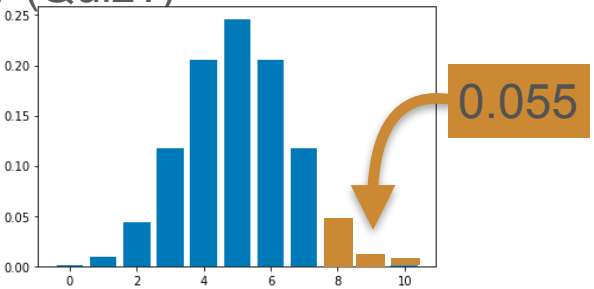
Hypothesis Testing

- Quiz: If we were to assume that the coin is unbiased, what is the probability that it falls in heads 8 times?
  - Answer: (10 choose 8) * 0.5^10

this is for unbiased



  - However, should we instead look at the probability of falling in heads 8 or more times? How much is this one? (Quiz?)
  - Answer:
    ((10 choose 8) +
    (10 choose 9) +
    (10 choose 10)) * 0.5^10

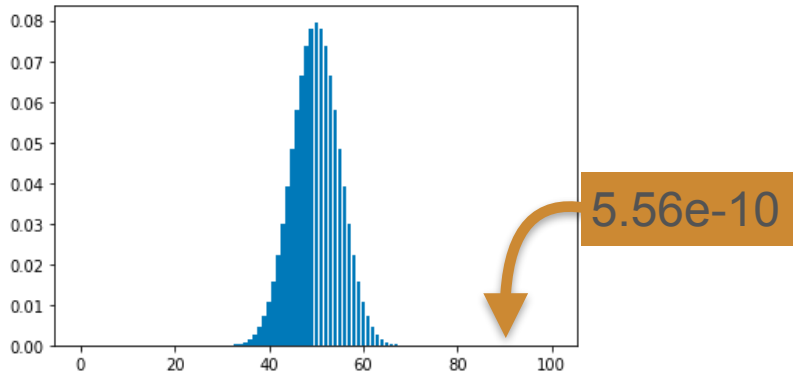


Hypothesis Testing

- If we assume that the coin is fair (**null hypothesis**)
- Then the probability that it lands in heads 8 times (**outcome**) is 0.055
- That probability is higher than 5%
    - Therefore the coin *could* potentially be fair (i.e., **we can't reject the null hypothesis**)

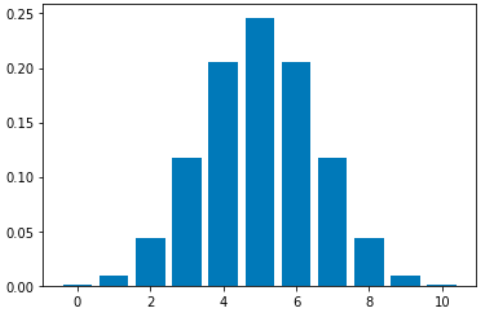
Hypothesis Testing

- Now, same problem except that we toss the coin 100 times and get heads 80 times.
- Probability of 80 or more heads:
  - Sum from i=80 to 100 of (100 choose i) * 0.5^100
  - The probability is TINY
- Therefore, we reject the null hypothesis
  - We conclude the coin is not biased
- Problem: A huge sum of tiny numbers to calculate
- Solution: Approximate with a Gaussian!

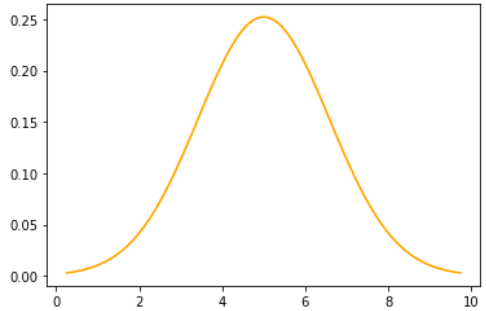


Central Limits Theorem (-Ish)

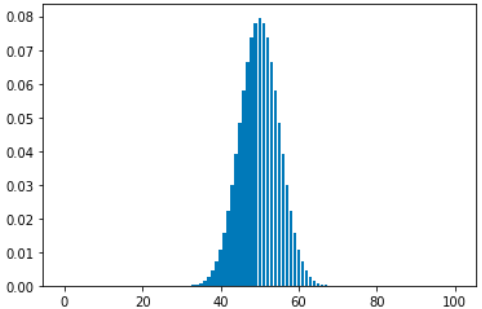
this is coved on W3



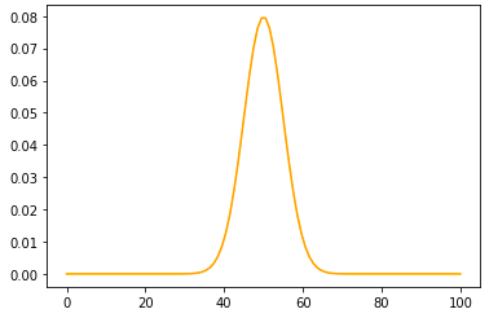
Binomial(10, 0.5)



Gaussian(5, $\sqrt{2.5}$)

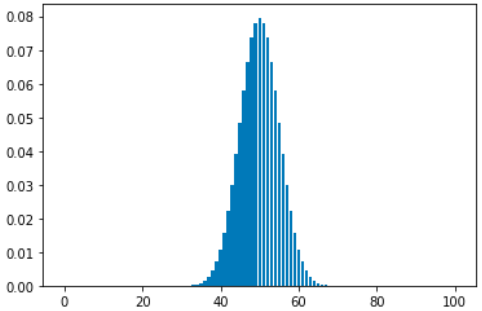


Binomial(100, 0.5)

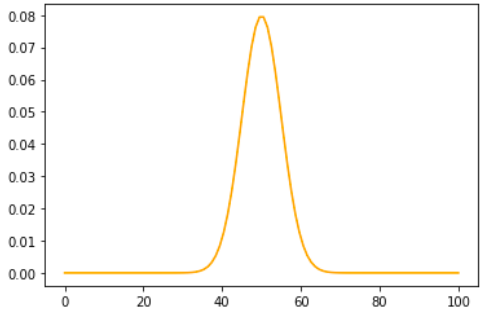


Gaussian(50, 5)

Central Limits Theorem (-lsh)



Binomial(n, p)



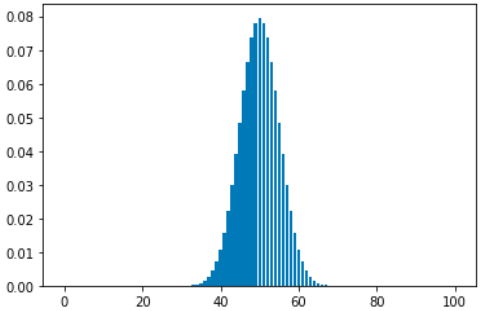
Gaussian(?, ?)

Gaussian($np, \sqrt{np(1-p)}$)

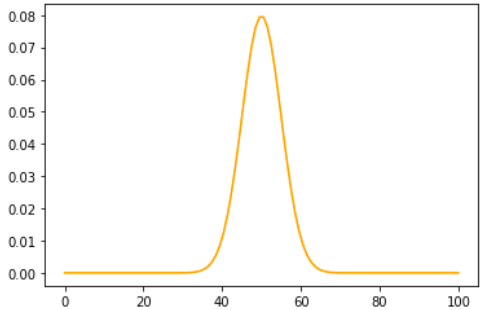
Mean = np
Variance = np(1-p)

Gaussian with:
mean=np
Variance = np(1-p)

Approximating the Binomial With a Gaussian



Binomial(100, 0.5)



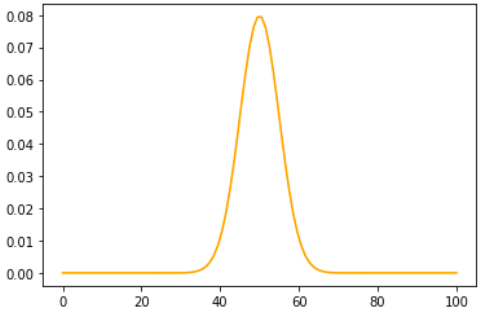
Gaussian(50, 5)

Sum of binomials from 80 to 100

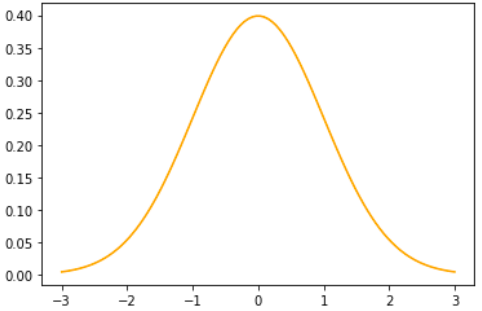
Area under the curve from 80 to 100

Can be calculated using CDF!

How To Do It? Normalize



Binomial(50, 5)



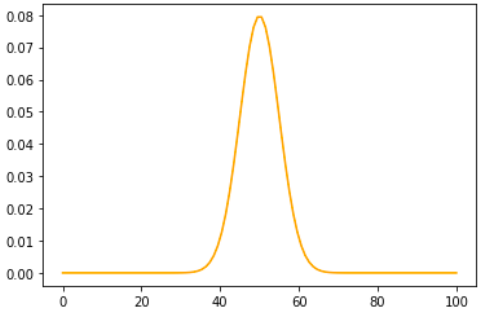
Gaussian(0, 1)

X

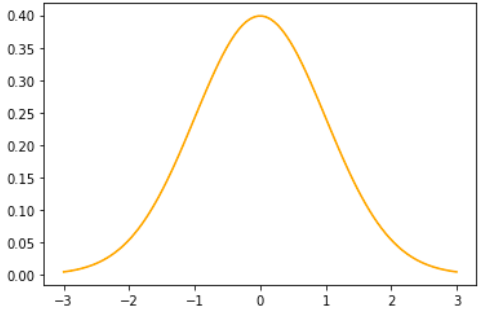
$$\frac{X - \text{mean}}{\text{std}}$$

$$\frac{X - 50}{5}$$

How To Do It? Normalize



Binomial(n, p)



Gaussian(0, 1)

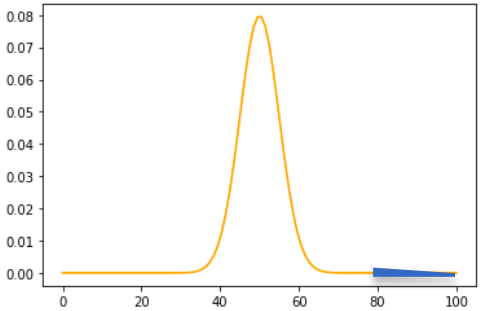
X

$$\mu = np$$
$$\sigma = np(1-p)$$

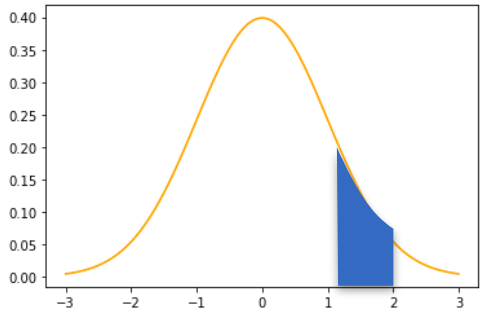
$$\frac{X - \text{mean}}{\text{std}}$$

$$\frac{X - \mu}{\sigma}$$

How To Do It? Normalize



Binomial(n, p)



Gaussian(0, 1)

P(80 < X < 100)

$$P\left(\frac{80-\mu}{\sigma} < \frac{X-\mu}{\sigma} < \frac{100-\mu}{\sigma}\right)$$

$$P\left(\frac{80-50}{5} < \frac{X-50}{5} < \frac{100-50}{5}\right)$$

$$= P(12 < Z < 20)$$

How To Do It? Normalize

$$P\left(\frac{80-50}{25} < \frac{X-50}{25} < \frac{100-50}{25}\right) = P(12 < Z < 20)$$

$$= \Phi(12) - \Phi(20)$$

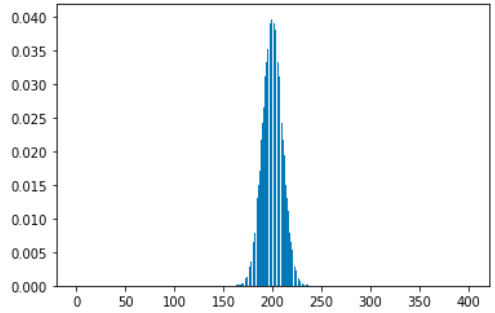
= almost 0

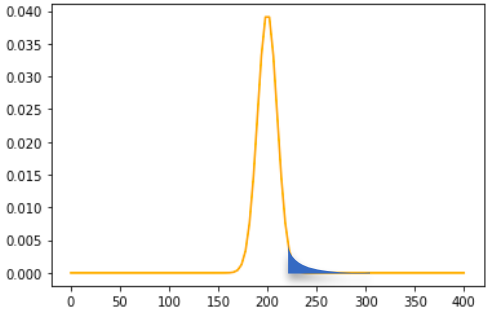
Conclusion: The coin must be biased

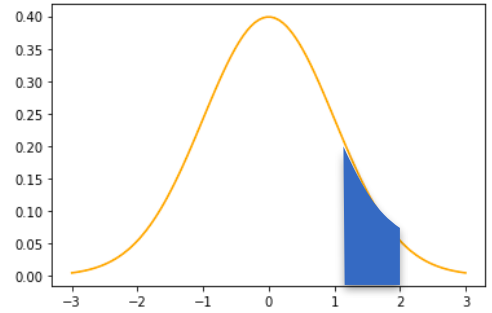
Why?
Because we reject the **null hypothesis** which says the coin is not biased.

Another Example

I toss a fair coin 400 times. What is the probability that the number of heads is between 250 and 350?







We can get this on Wiki

$$P\left(\frac{250-200}{100} < \frac{X-200}{100} < \frac{350-200}{100}\right)$$

$$P\left(0.5 < \frac{X-200}{100} < 1.5\right)$$

$$= P(0.5 < Z < 1.5)$$

$$= 0.2417$$

0.9332 - 0.6915

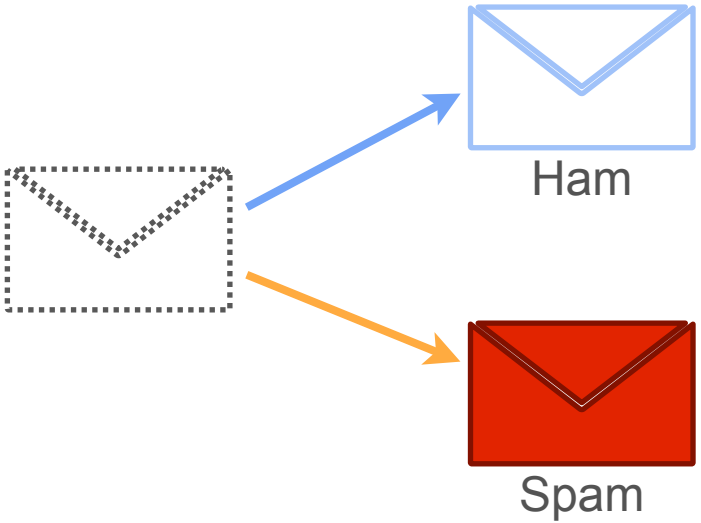
DeepLearning.AI

Hypothesis Testing

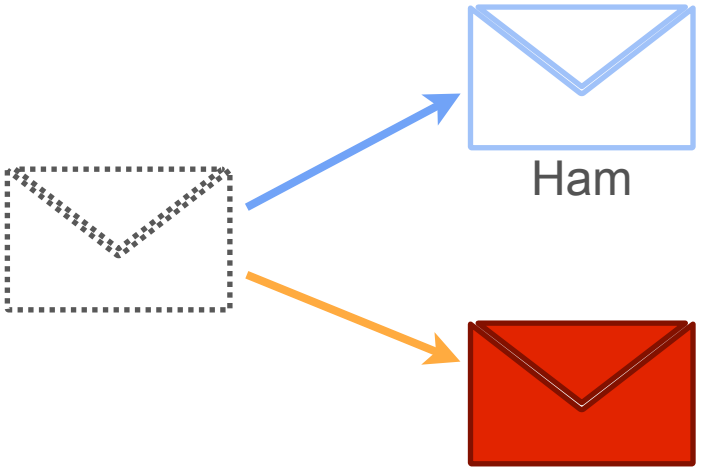
Defining hypothesis

Motivation

Motivation

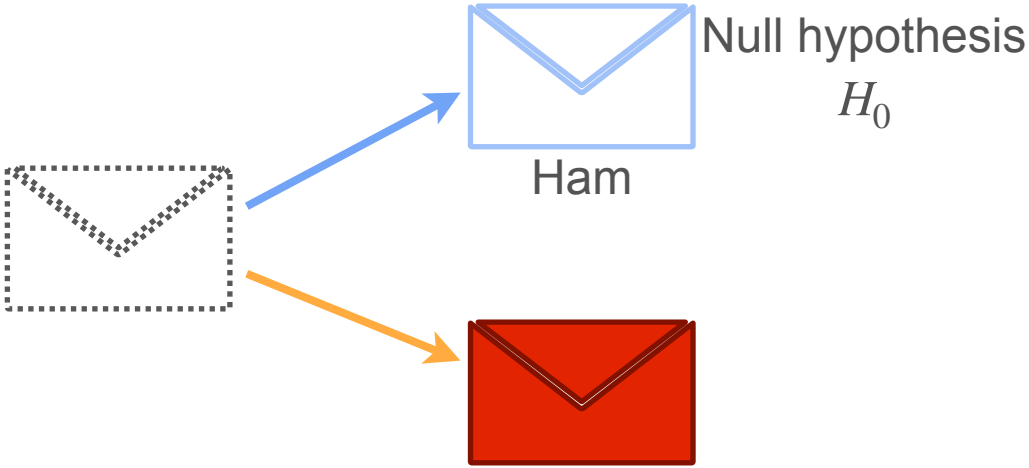


Motivation



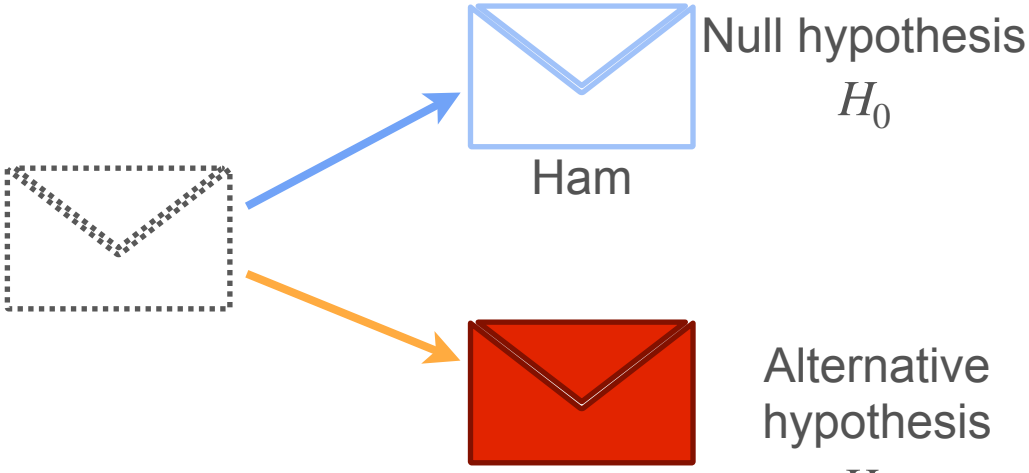
Email is assumed to be ham

Motivation



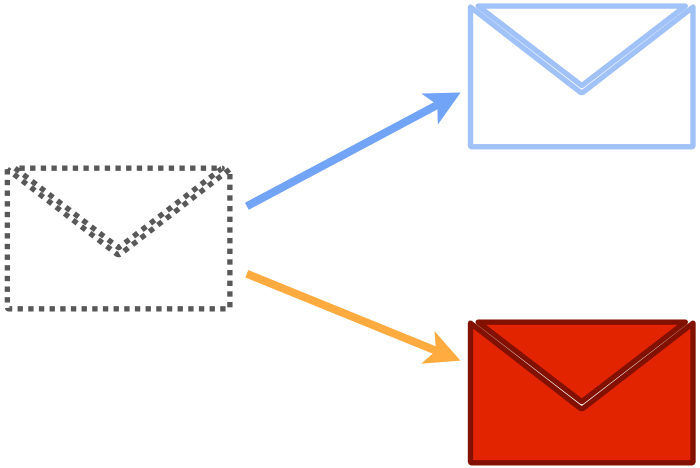
Email is assumed to be ham

Motivation



Email is assumed to be ham

Motivation



Null hypothesis

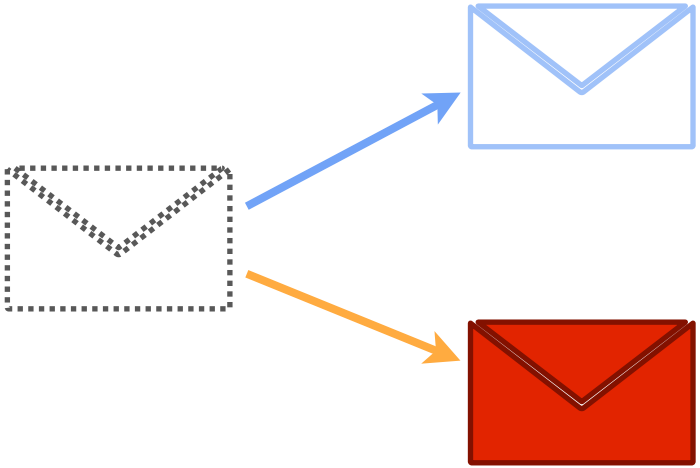
H_0

Alternative hypothesis

H_1

Email is assumed to be ham

Motivation



Null hypothesis
H_0

Alternative hypothesis
H_1

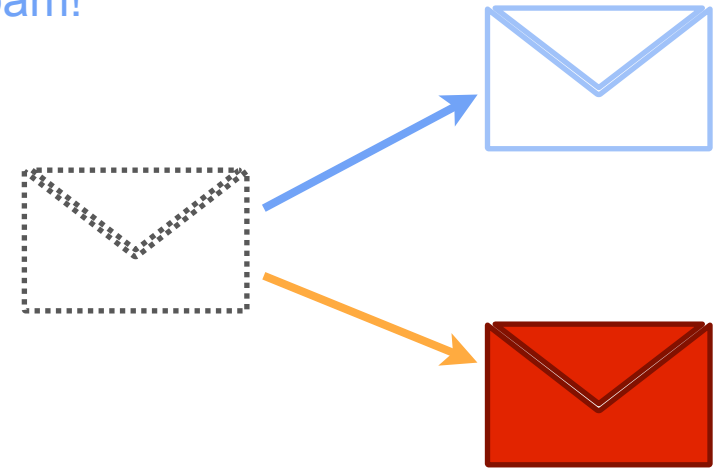
Mutually exclusive

True/False answer

Email is assumed to be ham

Motivation

When rejecting that the email is not spam, you are accepting that the email is spam!



Null hypothesis
H_0

Alternative hypothesis
H_1

Mutually exclusive

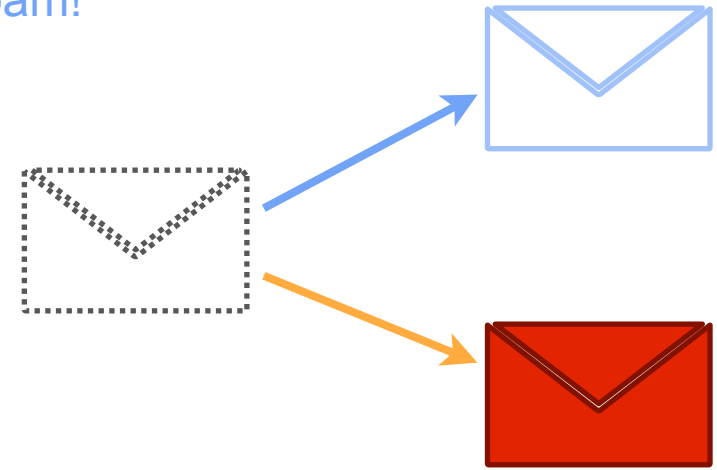
True/False answer

Email is assumed to be ham

Motivation

When rejecting that the email is not spam, you are accepting that the email is spam!

By failing to reject that the email IS spam, you are **not** accepting that it's ham



Null hypothesis
H_0

Alternative hypothesis
H_1

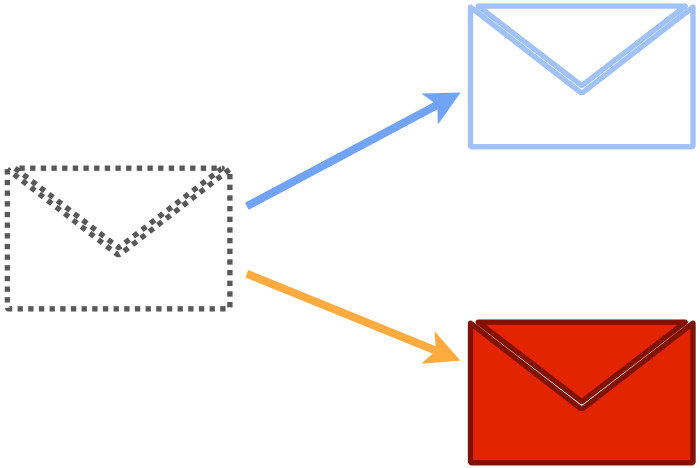
Mutually exclusive

True/False answer

Email is assumed to be ham

Motivation

Not labeling the email spam, doesn't mean the email is ham!



Null hypothesis

H_0

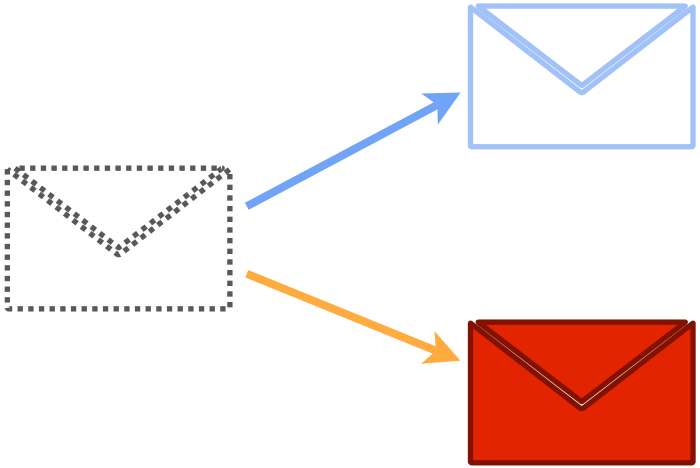
Alternative hypothesis

H_1

Email is assumed to be ham

Motivation

Not labeling the email spam, doesn't mean the email is ham!



Null hypothesis

H_0

Baseline

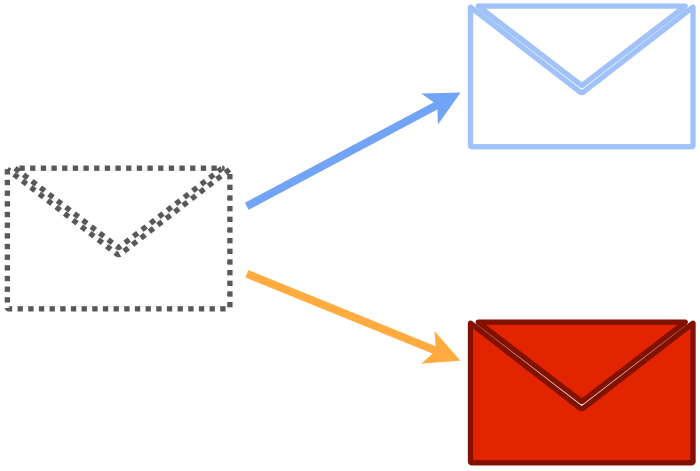
Alternative hypothesis

H_1

Email is assumed to be ham

Motivation

Not labeling the email spam, doesn't mean the email is ham!



Null hypothesis

H_0

Baseline

Alternative hypothesis

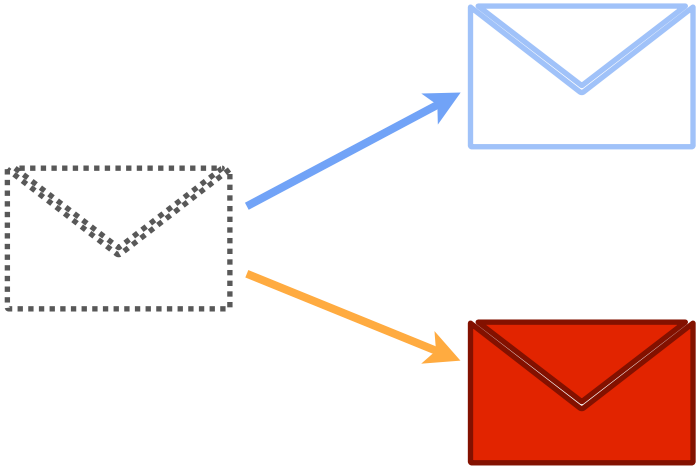
H_1

What you want to prove

Email is assumed to be ham

Motivation

Not labeling the email spam, doesn't mean the email is ham!



Null hypothesis

H_0

Baseline

Data

Evidence

Alternative hypothesis

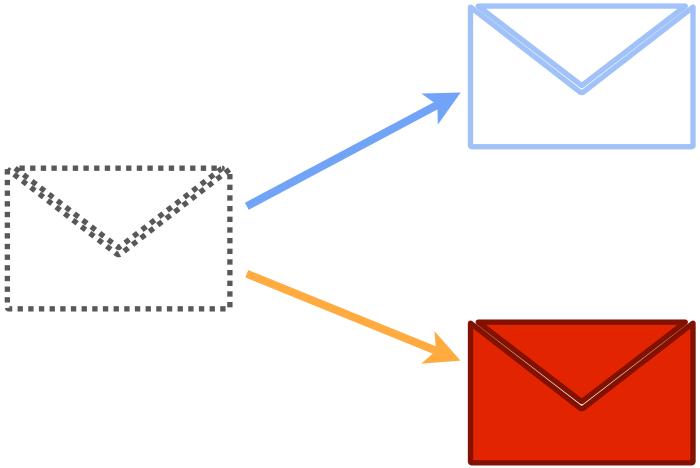
H_1

What you want to prove

Email is assumed to be ham

Motivation

Not labeling the email spam, doesn't mean the email is ham!



Email is assumed to be ham

Null hypothesis

H_0

Baseline

Alternative hypothesis

H_1

What you want to prove

Data

Evidence

Sender

Attachments

Size

Keywords

How To Determine the Result of the Test