Hypothesis Testing

Example

You are the production manager at a beverage manufacturer and you receive a bottling unit that has been recently re-adjusted so that it puts 200 milliliter of beverage in disposable plastic bottles.

You need to test that indeed the bottling unit puts in 200 milliliter of beverage.

For that you fill out 10 bottles using the unit at different times so as to obtain a random sample and very carefully measure the amount of beverage inside each bottle.

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Population mean claimed by the bottling unit

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Hypothesis Testing

The Central Limit Theorem

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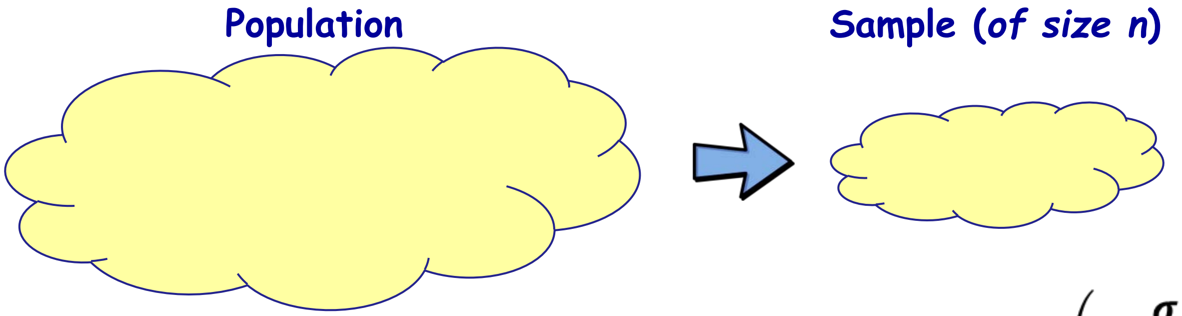
The Central Limit Theorem



$$\textbf{Mean} = \mu$$
$$\textbf{Std} = \sigma$$

$$\bar{x} \sim \textbf{Normal}\left(\mu, \frac{\sigma}{\sqrt{n}}\right)$$

Hypothesis Testing

The Central Limit Theorem

Population

Sample (*of size n*)

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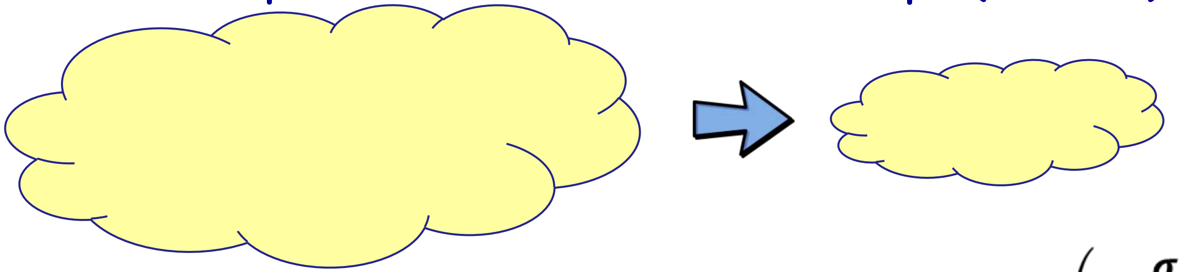
Hypothesis Testing

The Central Limit Theorem

Population **Sample (of size *n*)**



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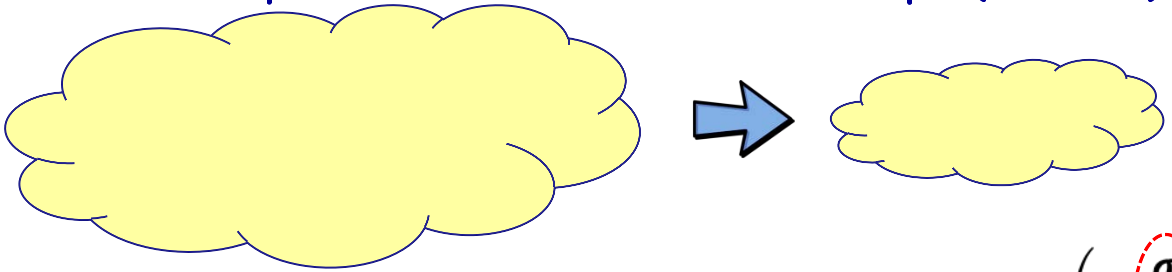

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Hypothesis Testing

The Central Limit Theorem

Population

all possible number of bottles that the unit can fill

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Sample (*of size 10*)

random sample of 10 bottles

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Hypothesis Testing

The Central Limit Theorem

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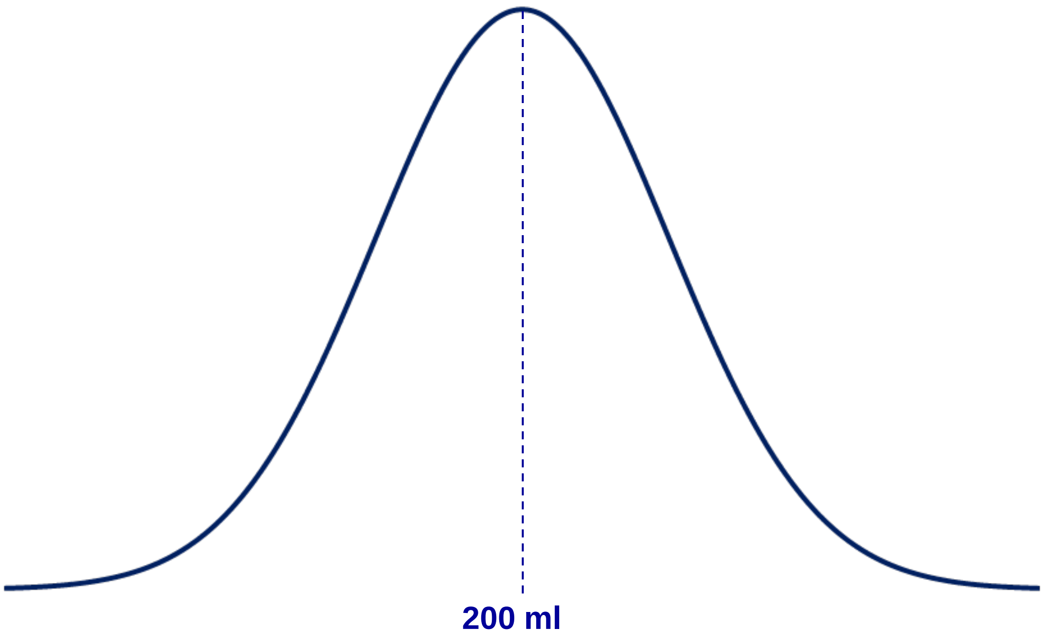
Hypothesis Testing

Distribution of sample mean *if the claim is correct*



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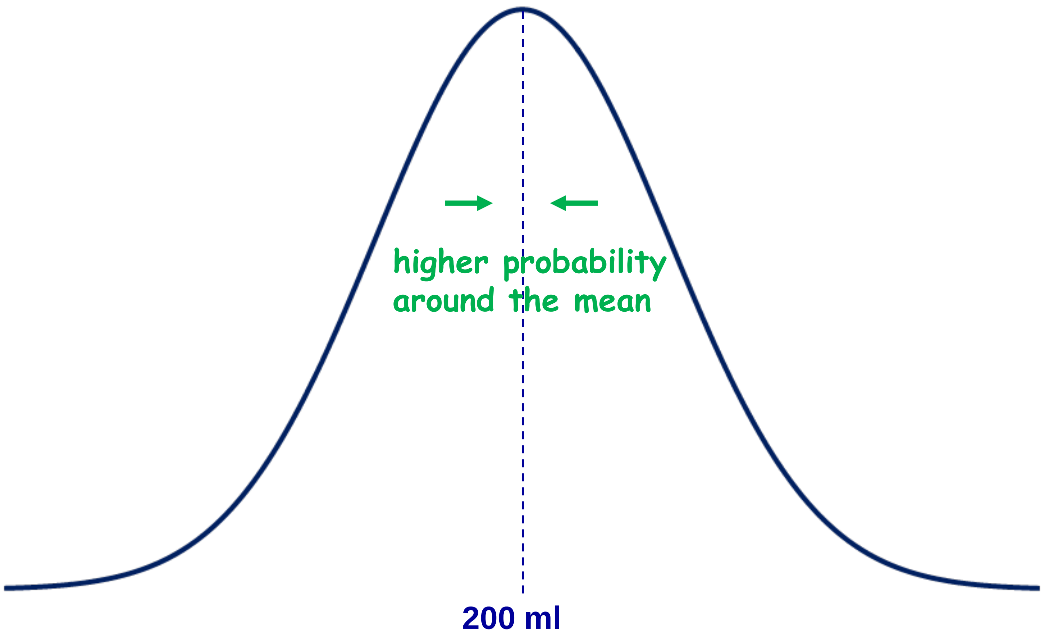

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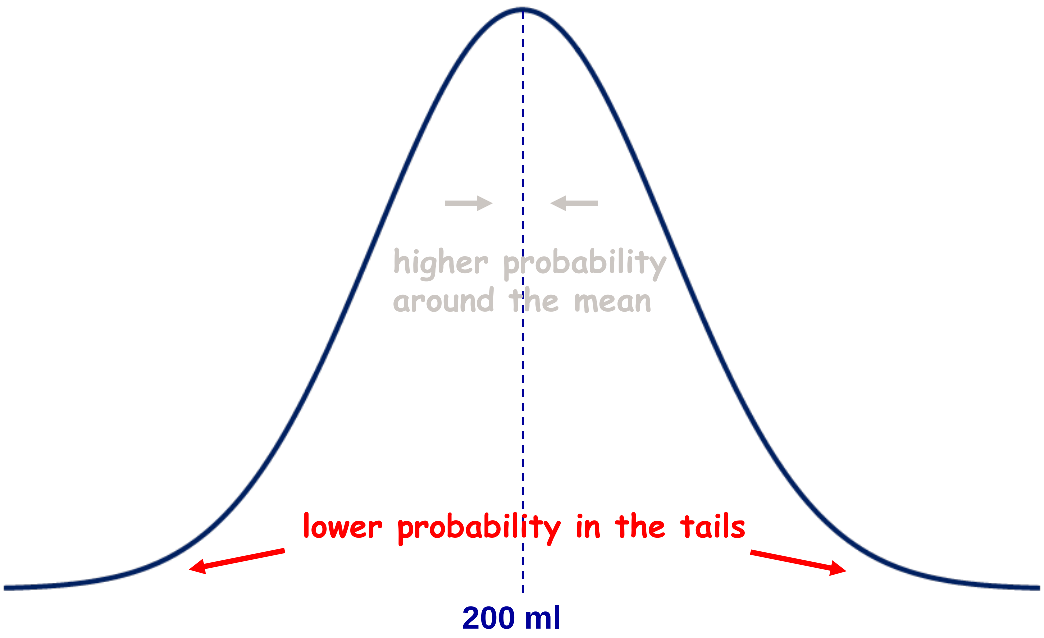

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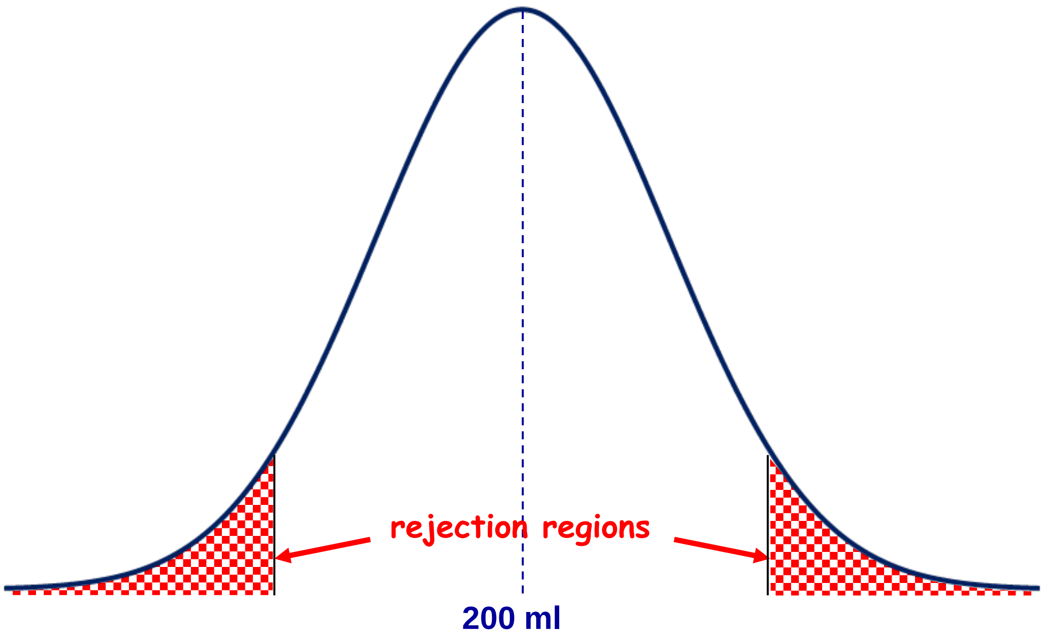

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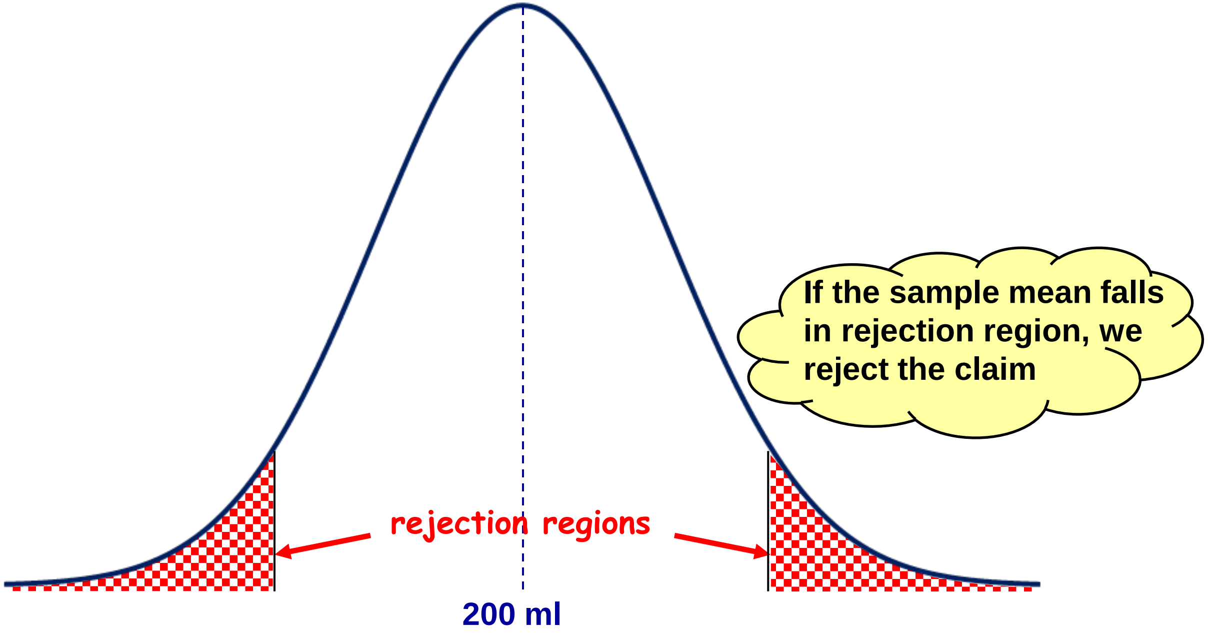

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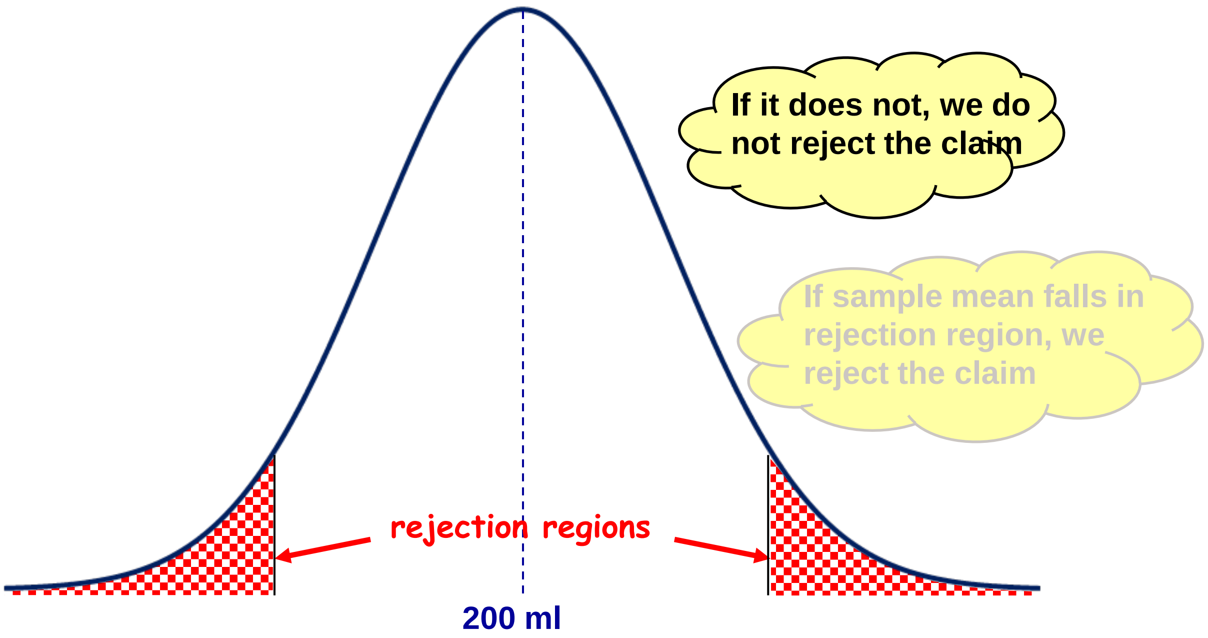

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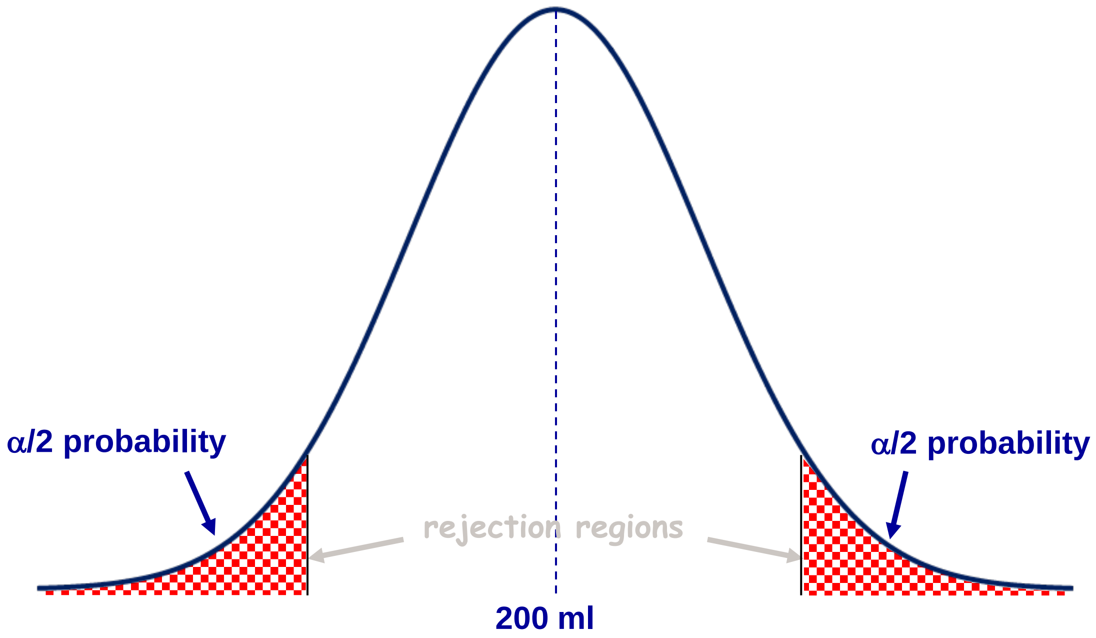

Hypothesis Testing

Distribution of sample mean

$$\bar{x} \sim \text{Normal}(\mu, \frac{\sigma}{\sqrt{n}})$$

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Hypothesis Testing

Distribution of sample mean

$$\bar{x} \sim \text{Normal}(\mu, \frac{\sigma}{\sqrt{n}}) \quad \Rightarrow \quad \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} \sim \text{Normal}(0, 1)$$

Hypothesis Testing

Distribution of sample mean

z-statistic

$$\bar{x} \sim \text{Normal}(\mu, \frac{\sigma}{\sqrt{n}}) \quad \Rightarrow \quad \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} \sim \text{Normal}(0, 1)$$

Hypothesis Testing

Distribution of sample mean

z-statistic

$$\bar{x} \sim \text{Normal}\left(\mu, \frac{\sigma}{\sqrt{n}}\right) \Rightarrow \frac{\bar{x}-\mu}{\sigma/\sqrt{n}} \sim \text{Normal}(0,1)$$

Sample mean falling in rejection region $\equiv$ The z-statistic falling in rejection region

Hypothesis Testing

Distribution of sample mean

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

t-statistic

(n-1 degrees of freedom)

Hypothesis Testing

Distribution of sample mean

t-statistic

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

Sample mean falling in rejection region $\equiv$ The ~~z-statistic~~ t-statistic falling in rejection region