

Statistical Methods for Plant Biology

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Anirudh V. S. Ruhil

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The Voinovich School of Leadership and Public Affairs

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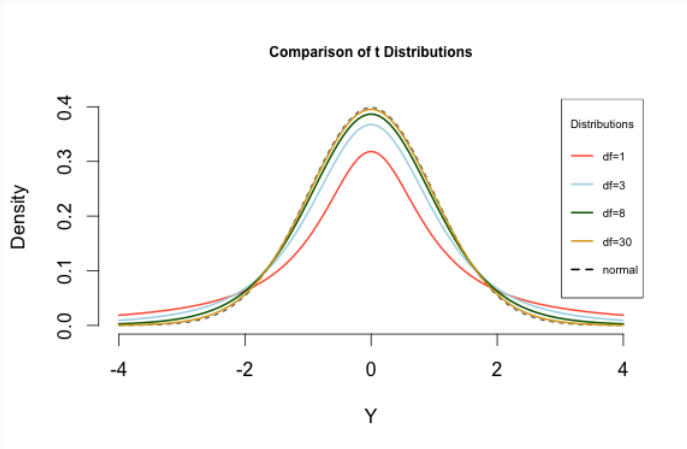
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Student's t Distribution

Student's t Distribution

z fails when σ is unknown and so we use s which, we know, varies from sample to sample

$$t = \frac{\bar{Y} - \mu}{SE_{\bar{Y}}}; \text{ where } SE_{\bar{Y}} = \frac{s}{\sqrt{n}}; df = n - 1; \text{ and CI is } \bar{Y} \pm t_{(\alpha/2, df)} (SE_{\bar{Y}})$$



Wolf Teeth

Measurements of the distance between the canine tooth and last molar of 35 wolf upper jaws were made by a researcher. Calculate the mean, standard deviation, and the 95 and 99% confidence intervals for the mean.

$$\bar{Y} = \frac{361.3}{35} = 10.3228$$

$$s = 0.3317 \text{ and } SE_{\bar{Y}} = \frac{s}{\sqrt{n}} = \frac{0.3317}{\sqrt{35}} = 0.0506$$

$$\text{Confidence Interval} = \bar{Y} \pm t_{(\alpha/2, df)} (SE_{\bar{Y}})$$

Critical t value for $\alpha = 0.05$ with $df = n - 1 = 35 - 1 = 34$ is 2.0322

$$\therefore 95\% \text{ CI} = 10.3228 \pm 2.0322 (0.0506) = [10.2089; 10.4368]$$

Critical t value for $\alpha = 0.01$ with $df = n - 1 = 35 - 1 = 34$ is 2.7283

$$\therefore 99\% \text{ CI} = 10.3228 \pm 2.7283 (0.0506) = [10.1698; 10.4758]$$

One-Sample t - test

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Definition

The one-sample t - test compares the mean (\bar{Y}) of a random sample from a normal population with the population mean (μ) proposed by H_0

Assumptions:

- 1 Random sample
- 2 Variable is normally distributed in the population

Test Statistic: $t = \frac{\bar{Y} - \mu_0}{SE_{\bar{Y}}}; df = n - 1$

Hypotheses can be two-tailed or one-tailed

Test sequence:

- 1 Specify hypotheses
- 2 Set α to 0.05 or 0.01
- 3 Calculate t
- 4 Reject H_0 if P - value of calculated t is $\leq \alpha$; Do not reject H_0 otherwise

Syrup vs. Water

Can a human swim faster in water or in syrup? It is unknown whether the increase in the friction of the body moving through the syrup (slowing the swimmer down) is compensated by the increased power of each stroke (speeding the swimmer up). In an experiment a pool was filled with water mixed with guar gum and another pool was filled with normal water. The researchers had 18 swimmers swim laps in both pools in random order. The data reflect the relative speed of each swimmer in syrup – i.e., speed in syrup divided by speed in water. If the syrup has no impact on speed then the relative swim speed should have a mean of 1.

H_0 : Relative speed is distributed with $\mu = 1$

H_A : Relative speed is distributed with $\mu \neq 1$

$\alpha = 0.05$; $df = n - 1 = 18 - 1 = 17$

$t_{(0.025,17)} = 2.1098$

The calculated $t = 1.1695$ with p -value = 0.2583. Since the p -value is not $\leq \alpha$ we do not reject H_0 ; relative speed appears to be distributed with $\mu = 1$ and hence we cannot conclude that humans swim faster or slower in syrup 8/10 versus in water.

Estimating Standard Deviation & Variance

Confidence Intervals for σ^2 and σ

Confidence Interval for the variance is given by

$$\frac{df(s^2)}{\chi_{\frac{\alpha}{2},df}^2} < \sigma^2 < \frac{df(s^2)}{\chi_{1-\frac{\alpha}{2},df}^2}$$

Confidence Interval for the standard deviation is given by

$$\sqrt{\frac{df(s^2)}{\chi_{\frac{\alpha}{2},df}^2}} < \sigma < \sqrt{\frac{df(s^2)}{\chi_{1-\frac{\alpha}{2},df}^2}}$$

Example

$$s_{swim}^2 = 0.00179; df = 17; \chi_{0.025,17}^2 = 7.564186; \chi_{0.975,17}^2 = 30.19101$$

$$\therefore 95\% \text{ CI for Variance is } \frac{17(0.00179)}{30.19101} \text{ and } \frac{17(0.00179)}{7.564186} = [0.001008578, 0.004025549]$$

$$\text{and } 95\% \text{ CI for Std. Dev. : } \left[\sqrt{0.001008578}, \sqrt{0.004025549} \right] = [0.03175812, 0.06344721]$$