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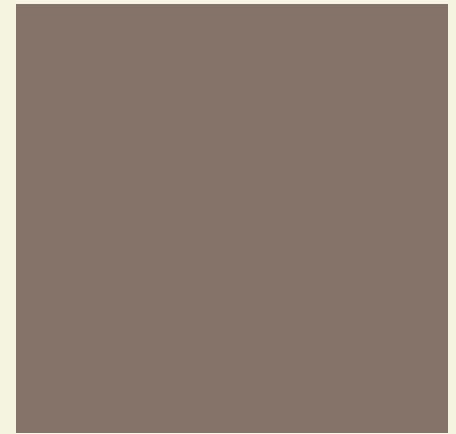
# ICCPP-STATISTICS

- Independent Samples T Test

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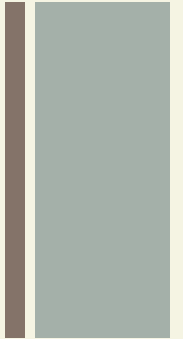


## William Sealy Gosset (1876-1937)

Independent Samples T Test



# Definition



- The independent samples t test (also called the unpaired samples t test) is the most common form of the T test. It helps you to compare the means of two sets of data.

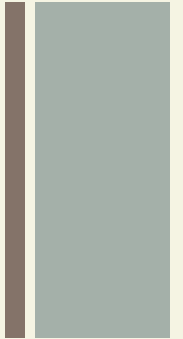
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# Independent Samples T Test

$$t = \frac{\mu_A - \mu_B}{\sqrt{\left[ \frac{\left( \sum A^2 - \frac{(\sum A)^2}{n_A} \right) + \left( \sum B^2 - \frac{(\sum B)^2}{n_B} \right)}{n_A + n_B - 2} \right] \cdot \left[ \frac{1}{n_A} + \frac{1}{n_B} \right]}}$$



# T Test types



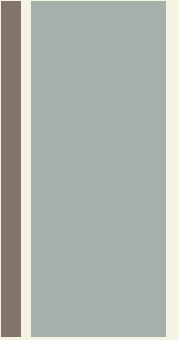
**One sample t test:** used to compare a result to an expected value.

**Paired t test (dependent samples):** used to compare related observations.

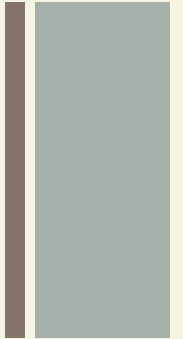
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You should use this test when:

- You do not know the population mean or standard deviation.
- You have two independent, separate samples.



# + Assumptions



1.

**Assumption of Independence:** you need two independent, categorical groups that represent your independent variable.

# + Assumptions

## 2.

**Assumption of normality:** the dependent variable should be approximately normally distributed. The dependent variable should also be measured on a continuous scale.



# + Assumptions

## 3.

**Assumption of Homogeneity of Variance:** The variances of the dependent variable should be equal.

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# Example

Calculate an independent samples t test for the following data sets:

Data set A: 1,2,2,3,3,4,4,5,5,6

Data set B: 1,2,4,5,5,5,6,6,7,9

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## Solution Step Wise

### Step 1

Sum the two groups:

$$A: 1 + 2 + 2 + 3 + 3 + 4 + 4 + 5 + 5 + 6 = 35$$

$$B: 1 + 2 + 4 + 5 + 5 + 5 + 6 + 6 + 7 + 9 = 50$$

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# Solution Step Wise

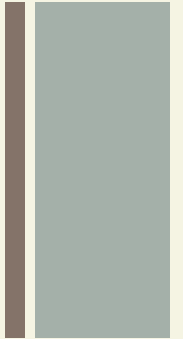
## Step 2

Square the sums from Step 1:

$$35^2 = 1225$$

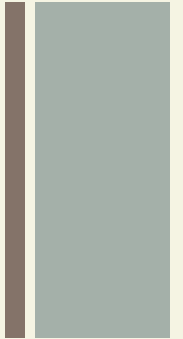
$$49^2 = 2500$$

Set these numbers aside for a moment



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## Solution Step Wise



### Step 3

Calculate the means for the two groups:

$$A: (1 + 2 + 2 + 3 + 3 + 4 + 4 + 5 + 5 + 6)/10 = 35/10 = 3.5$$

$$B: (1 + 2 + 4 + 5 + 5 + 5 + 6 + 6 + 7 + 9) = 50/10 = 5$$

Set these numbers aside for a moment.

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## Solution Step Wise

### Step 4

Square the individual scores and then add them up:

$$A: 1^1 + 2^2 + 2^2 + 3^3 + 3^3 + 4^4 + 4^4 + 5^5 + 5^5 + 6^6 = 145$$

$$B: 1^2 + 2^2 + 4^4 + 5^5 + 5^5 + 5^5 + 6^6 + 6^6 + 7^7 + 9^9 = 298$$

Set these numbers aside for a moment.

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## Solution Step Wise

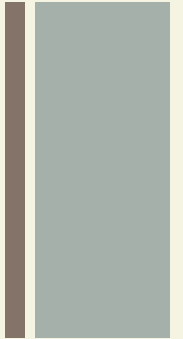
### Step 5

Insert your numbers into the following formula and solve:

$$t = \frac{\mu_A - \mu_B}{\sqrt{\left[ \frac{\left( \sum A^2 - \frac{(\sum A)^2}{n_A} \right) + \left( \sum B^2 - \frac{(\sum B)^2}{n_B} \right)}{n_A + n_B - 2} \right] \cdot \left[ \frac{1}{n_A} + \frac{1}{n_B} \right]}}$$



# Solution Step Wise



- $(\sum A)^2$ : Sum of data set A, squared (Step 2)
- $(\sum B)^2$ : Sum of data set B, squared (Step 2)
- $\mu A$ : Mean of data set A (Step 3)
- $\mu B$ : Mean of data set B (Step 3)
- $\sum A^2$ : Sum of the squares of data set A (Step 4)
- $\sum B^2$ : Sum of the squares of data set B (Step 4)
- $nA$ : Number of items in data set A
- $nB$ : Number of items in data set B



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## Solution Step Wise

Insert your numbers into the following formula and solve:

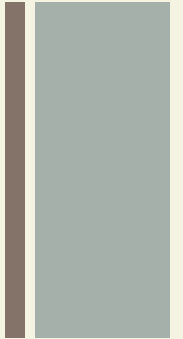
$$t = \frac{3.5 - 5}{\sqrt{\left[ \frac{\left(145 - \frac{1225}{10}\right) + \left(298 - \frac{2500}{10}\right)}{10 + 10} \right] \cdot \left[ \frac{1}{10} + \frac{1}{10} \right]}}$$

$$t = \frac{-1.5}{\sqrt{\left[ \frac{(145 - 122.5) + (298 - 250)}{18} \right] \cdot \left[ \frac{2}{10} \right]}}$$

$$t = \frac{-1.5}{\sqrt{3.917 \cdot \frac{2}{10}}} = \frac{-1.5}{\sqrt{0.783}} = -1.69$$

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# Solution Step Wise



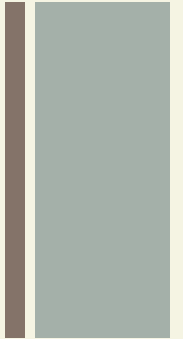
## Step 6

Find the Degrees of freedom

$$(n_A - 1 + n_B - 1) = 18$$



# Solution Step Wise



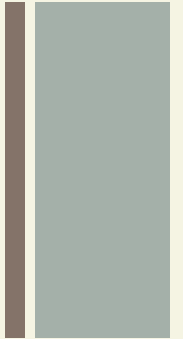
## Step 7

Look up your degrees of freedom in the t-table. If you don't know what your alpha level is, use 5% (0.05).

18 degrees of freedom at an alpha level of 0.05 = 2.10



# Solution Step Wise



## Step 8

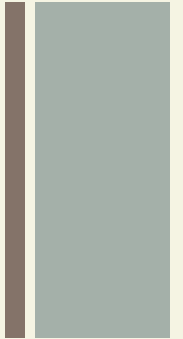
Compare your calculated value (Step 5) to your table value (Step 7). The calculated value of -1.79 is less than the cutoff of 2.10 from the table.

Therefore  $p > .05$ .

As the p-value is greater than the alpha level, we cannot conclude that there is a difference between means.



# References



Everitt, B. S.; Skrondal, A. (2010), The Cambridge Dictionary of Statistics, Cambridge University Press.

Gonick, L. (1993). The Cartoon Guide to Statistics. HarperPerennial.

Levine, D. (2014). Even You Can Learn Statistics and Analytics: An Easy to Understand Guide to Statistics and Analytics 3rd Edition. Pearson FT Press

Salkind, N. (2016). Statistics for People Who (Think They) Hate Statistics: Using Microsoft Excel 4th Edition.

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