



ANOVA Test

What is the ANOVA Test?

- ANOVA: Analysis of Variance
- Variance is how spread out data is from mean
 - Randomness
- Significance
 - Null hypothesis vs alternative hypothesis



Why this test is needed?

- Differences between groups
- IV vs. Randomness
- Null hypothesis vs alternative hypothesis
 - Null: randomness
 - Alternate: caused by IV



When should ANOVA be used

- Significant difference between groups
- Used when
 - Continuous Data
 - Quantitative Data
 - 2+ testing groups
 - 1 dependent variable
- Energy drinks on Blood Pressure:
 - 2 drinks (2+ groups)
 - Blood pressure (1 dependent variable).



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<https://drizly.com/extras/beverages/sports-drinks/gatorade-blue/p3465>

(n.d.). Retrieved from

<https://www.amazon.com/Tropical-Servings-Energy-Endurance-Formula/dp/B01H0MTUHO>

It's just water. (2018). Retrieved from

<https://www.sciencenews.org/article/engineering-clean-drinking-water-treatment-pollution>



Capritto, A. (2019). *Blood pressure*. Retrieved from

<https://www.cnet.com/how-to/how-to-take-your-blood-pressure-at-home/>

"One-Way" or "Two-Way"

- # of IVs
 - One-Way: 1 IV
 - *One-Way can only have 2 levels
 - Two-Way: 2+ IVs
- Levels / Categories
- Example: One-way is different brands of soda, two-way is flavor



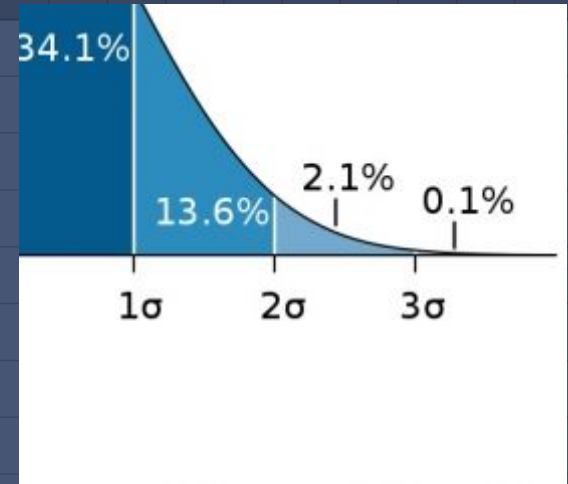
Wanna sprite cranberry? (n.d.). Retrieved from <https://www.coca-colacompany.com/press-center/image-library/sprite-cranberry>
(n.d.). Retrieved from <https://www.officedepot.com/a/products/208255/Sprite-12-Oz-Case-Of-24/>

How to present the test

- State One-Way / Two-Way
- State conditions
- $F(\underline{\mathbf{A}}, \underline{\mathbf{B}}) = \underline{\mathbf{C}}, p = \underline{\mathbf{D}}$
 - **A**: # of IVs
 - **B**: degrees of freedom
 - Degrees of Freedom: (Sample size - 1)
 - **C**: F value
 - the F value is the ratio of the mean squares, which is the data value

How to present the test (cont.)

- $F(\underline{A}, \underline{B}) = \underline{C}, p = \underline{D}$
- D is the p value
 - 0.05 = 95% = 2 sigmas
 - $p < 0.05 \rightarrow$ significant
 - $p > 0.05 \rightarrow$ insignificant
- An example is: $F(2, 39) = 4.20, p = 0.03$
- Significant \rightarrow ad hoc test
 - Ad hoc - another test after ANOVA to confirm significance



Chandler, D. L. (n.d.). Retrieved from <http://news.mit.edu/2012/explained-sigma-0209>

Real Example

Table 2: Summary of ANOVA

N		Mean		Mean Difference (High-Low)	F	P
Low SS	High SS	Low SS	High SS			
21	32	49.43	59.1	9.67	5.36	0.25

Note: Effect size $\eta^2 = .28$, $df=51$

- N: sample size
- SS: Safety & Security
- Effect size: 0.28 → notable
- $F(1,51)=5.36$
- $p = 0.25$, $p > 0.05$
- F and p value show data is significant

Infographic

ANOVA ANALYSIS OF VARIANCE

WHAT IS ANOVA?

ANOVA is a statistical test used to determine if experimental results are significant. It does this by determining if there is a significant difference between two or more groups, which can lead to the null hypothesis being rejected or causing the alternate hypothesis to be accepted.

WHY IS IT NEEDED

ANOVA is needed to determine if the null hypothesis should be accepted or if the alternative hypothesis should be accepted. This helps determine if the difference in the data is caused by randomness (also known as variance) or if the difference was caused by the independent variable(s).

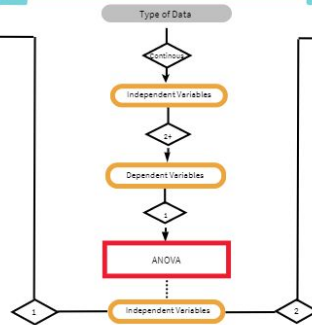
WHEN TO USE IT

One-Way ANOVA

One-way ANOVA is used to compare the means from two unrelated groups. For this type of ANOVA, the null hypothesis would be that the means of the two groups are not significantly different. Limitations for one-way ANOVA is that the test can only be used for one IV that affects the DV. Another limitation is that it can be used to determine if there is a difference between multiple groups, but it will not determine which groups are different.

Two-Way ANOVA

Two-way ANOVA is an extension of one-way ANOVA, with the exception that it can test two independent variables instead of one. This means that if there are two IVs that could possibly affect the DV, ANOVA could be used to test if those IVs actually affect the DV. Two-way ANOVA, however, requires a lot more assumptions to function. The assumptions are: the population should be close to normal distribution, the population variances are equal, the groups have an equal sample size, and the samples are independent.



EXAMPLE

Table 2: Summary of ANOVA

N		Mean		Low SS		High SS		Mean Difference (High-Low)	F	P
21	32	49.43	59.1	9.67	5.36	0.25				

Note: Effect size $\eta^2 = .28$, $df=51$

In this example, a researcher used ANOVA in order to examine the relationship between safety and security (SS) and human development. There were a total of 53 participants, which is shown in the N column. The average human development is shown in the Mean column, with their difference being shown in Mean Difference.

Only one independent variable (which was SS), was used, which is why the researcher used one-way ANOVA. Calculating the F value using the 51 as the degrees of freedom (df), the F value was 5.36 with a p-value of 0.25 is acquired. This meant that the ANOVA was significant.

Works Referenced

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McLeod, S. (n.d.). Saul McLeod. Retrieved from <https://www.simplypsychology.org/effect-size.html>.

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