

+

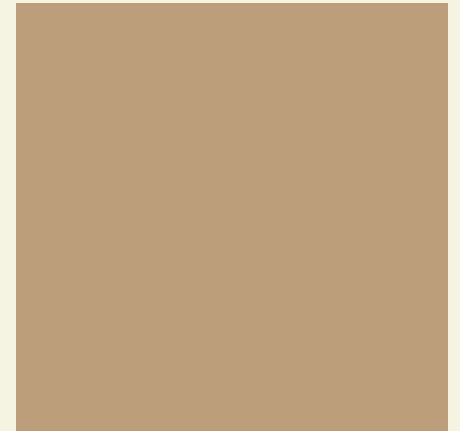
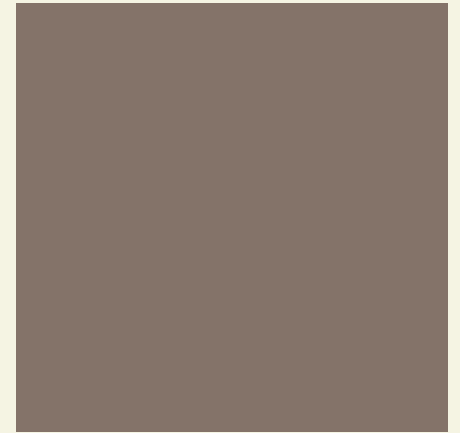
ICCPP-STATISTICS

- Tukey's range test

Vishal Lohchab

*Scientific Assistant of
Prof. Dr. Hans-Werner Gessmann
Director ICCPP International*





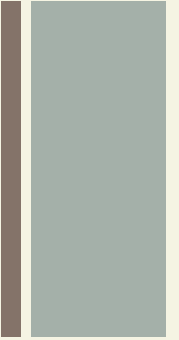
John Wilder Tukey (1915-2000)

Tukey's range test

+ Definition

- Tukey's range test is a single-step multiple comparison procedure and statistical test.

It can be used to find means that are significantly different from each other.



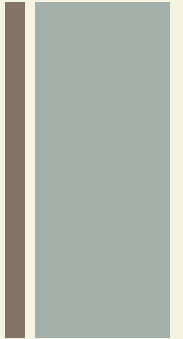
+ Tukey's range test

- An ANOVA test can tell you if your results are significant overall, but it won't tell you exactly where those differences lie.

After you have run an ANOVA and found significant results, then you can run Tukey's HSD to find out which specific groups means (compared with each other) are different.

The test compares all possible pairs of means.

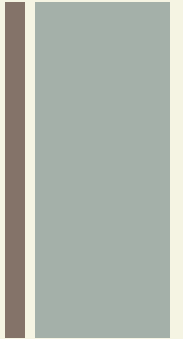
+ Use



- The Tukey post-hoc test should be used when you would like to make pairwise comparisons between group means when the sample sizes for each group are equal.



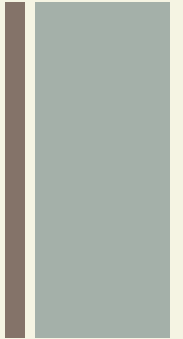
Assumptions



- The observations being tested are independent within and among the groups.
- The groups associated with each mean in the test are normally distributed.



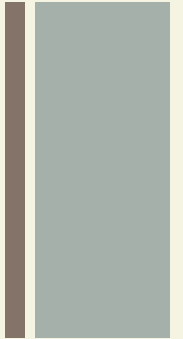
Assumptions



- There is equal within-group variance across the groups associated with each mean in the test (homogeneity of variance).



The test statistic



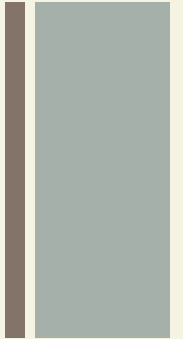
- Tukey's test is based on a formula very similar to that of the t-test.

In fact, Tukey's test is essentially a t-test, except that it corrects for family-wise error rate.

The formula for Tukey's test is: $q_s = \frac{Y_A - Y_B}{SE}$,



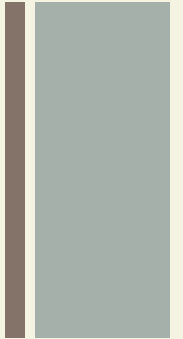
The test statistic



- where Y_A is the larger of the two means being compared, Y_B is the smaller of the two means being compared, and S_E is the standard error of the sum of the means.
- This q_s value can then be compared to a q value from the studentized range distribution.



The test statistic

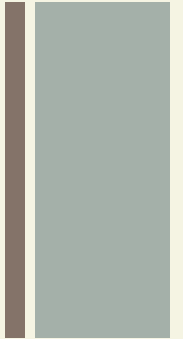


- If the q_s value is larger than the critical value q_α obtained from the distribution,

the two means are said to be significantly different at level $\alpha : 0 \leq \alpha \leq 1$



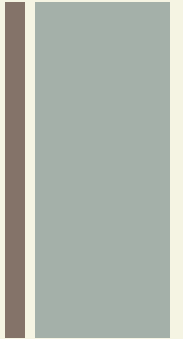
The test statistic



- Since the null hypothesis for Tukey's test states that all means being compared are from the same population (i.e. $\mu_1 = \mu_2 = \mu_3 = \dots = \mu_k$), the means should be normally distributed.

This gives rise to the normality assumption of Tukey's test.

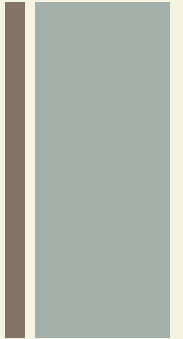
+ General Steps



Step 1

Perform the ANOVA test. Assuming your F value is significant, you can run the post hoc test

+ General Steps

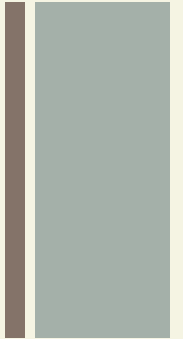


Step 2

Choose two means from the ANOVA output. Note the following:

- * Means,
- * Mean Square Within,
- * Number per treatment/group,
- * Degrees of freedom Within.

+ General Steps



Step 3

Find the critical value in The Q table.

For this, you'll need k , which is the number of groups or treatments and degrees of freedom for the error term.

+ General Steps

Step 4

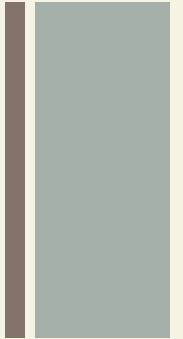
Calculate the HSD statistic for the Tukey test using the formula:

$$T = q \cdot \sqrt{\frac{MSE}{n}}$$

You'll get MSE from the Anova output (MS error term);

“n” is the number of items in one sample.

+ General Steps



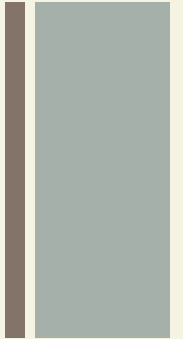
Step 5

Compare the score you calculated in Step 3 with the tabulated value you found in Step 4.

If the calculated value from Step 3 is bigger than the critical value from the Q table, the two means are significantly different.



References



https://en.wikipedia.org/wiki/Tukey%27s_range_testm, date 28.08.21, 20:00 h MET

Tukey J (1949): "Comparing Individual Means in the Analysis of Variance". *Biometrics*. 5 (2): 99–114. JSTOR 3001913.

Linton L R, Harder L D (2007): *Biology 315 – Quantitative Biology Lecture Notes*. University of Calgary, Calgary, AB

Brillinger D: "The Collected Works of John W. Tukey". 1984.

Glen S: "Welcome to Statistics How To!" From [StatisticsHowTo.com](https://www.statisticshowto.com/): Elementary Statistics for the rest of us!

<https://www.statisticshowto.com/>, date 28.08.21, 20:00 h MET