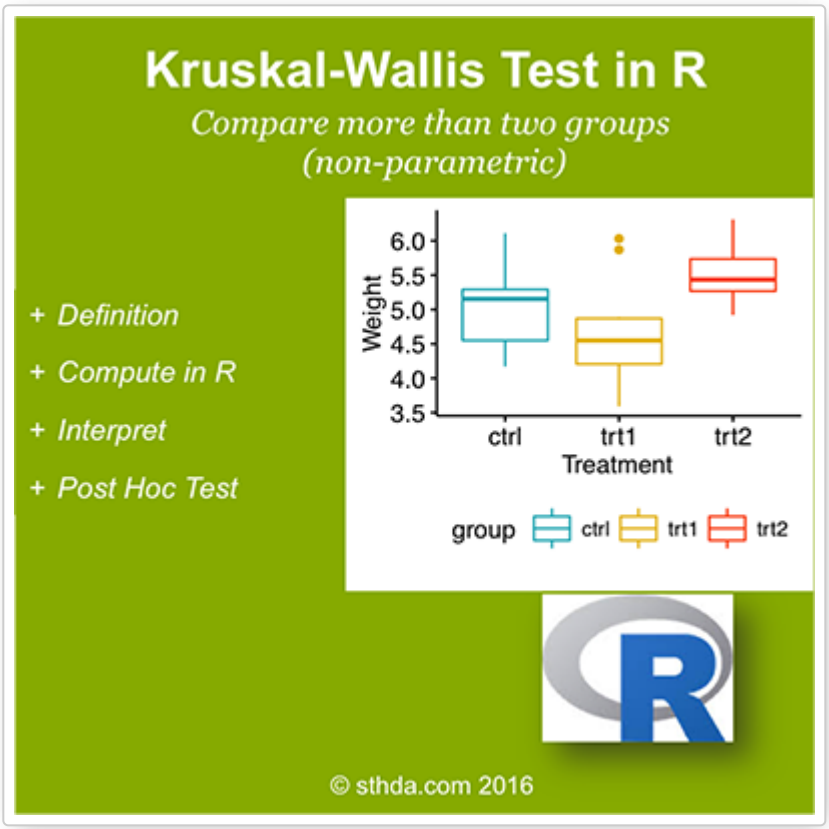
Kruskal-Wallis Test in R

What is Kruskal-Wallis test?

Kruskal-Wallis test by rank is a **non-parametric alternative** to one-way **ANOVA test**, which extends the two-samples Wilcoxon test in the situation where there are more than two groups. It's recommended when the assumptions of one-way ANOVA test are not met. This tutorial describes how to compute Kruskal-Wallis test in **R** software.



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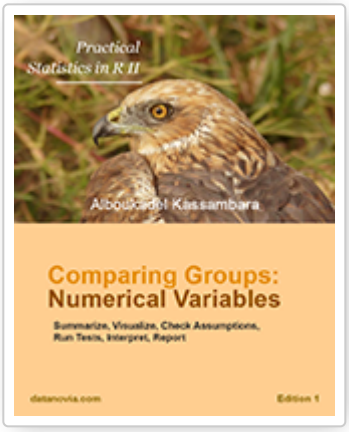


Practical Statistics in R for Comparing Groups: Numerical Variables

Visualize your data and compute Kruskal-Wallis test in R

Import your data into R

1. **Prepare your data** as specified here: Best practices for preparing your data set for R

2. **Save your data** in an external .txt tab or .csv files
3. **Import your data into R** as follow:

```
# If .txt tab file, use this
my_data <- read.delim(file.choose())
# Or, if .csv file, use this
my_data <- read.csv(file.choose())
```

Here, we'll use the built-in R data set named *PlantGrowth*. It contains the weight of plants obtained under a control and two different treatment conditions.

```
my_data <- PlantGrowth
```

Check your data

```
# print the head of the file
head(my_data)
```

```
  weight group
1   4.17  ctrl
2   5.58  ctrl
3   5.18  ctrl
4   6.11  ctrl
5   4.50  ctrl
6   4.61  ctrl
```

> ! In R terminology, the column "group" is called factor and the different categories ("ctr", "trt1", "trt2") are named factor levels. **The levels are ordered alphabetically**.

```
# Show the group levels
levels(my_data$group)
```

```
[1] "ctrl" "trt1" "trt2"
```

If the levels are not automatically in the correct order, re-order them as follow:

```
my_data$group <- ordered(my_data$group,
                         levels = c("ctrl", "trt1", "trt2"))
```

It's possible to compute summary statistics by groups. The dplyr package can be used.

- To install **dplyr** package, type this:

```
install.packages("dplyr")
```

- Compute summary statistics by groups:

```
library(dplyr)
group_by(my_data, group) %>%
  summarise(
    count = n(),
    mean = mean(weight, na.rm = TRUE),
    sd = sd(weight, na.rm = TRUE),
    median = median(weight, na.rm = TRUE),
    IQR = IQR(weight, na.rm = TRUE)
  )
```

```
Source: local data frame [3 x 6]
   group count  mean        sd median    IQR
  (fctr) (int) (dbl)     (dbl)  (dbl)  (dbl)
1   ctrl    10 5.032 0.5830914  5.155 0.7425
2   trt1    10 4.661 0.7936757  4.550 0.6625
3   trt2    10 5.526 0.4425733  5.435 0.4675
```

Visualize the data using box plots

- To use R base graphs read this: R base graphs. Here, we'll use the **ggpubr** R package for an easy ggplot2-based data visualization.
- Install the latest version of ggpubr from GitHub as follow (recommended):

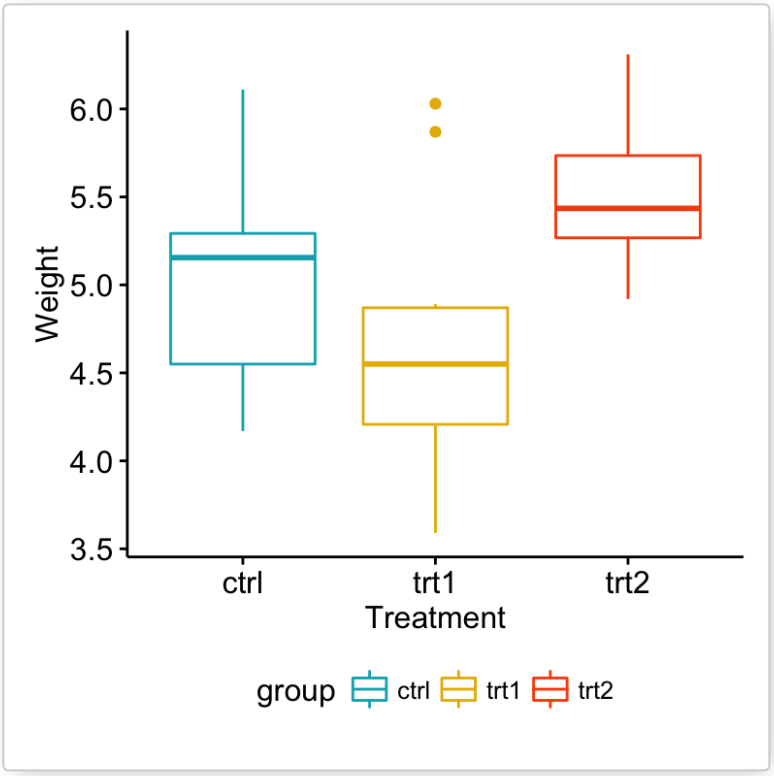
```
# Install
if(!require(devtools)) install.packages("devtools")
devtools::install_github("kassambara/ggpubr")
```

- Or, install from CRAN as follow:

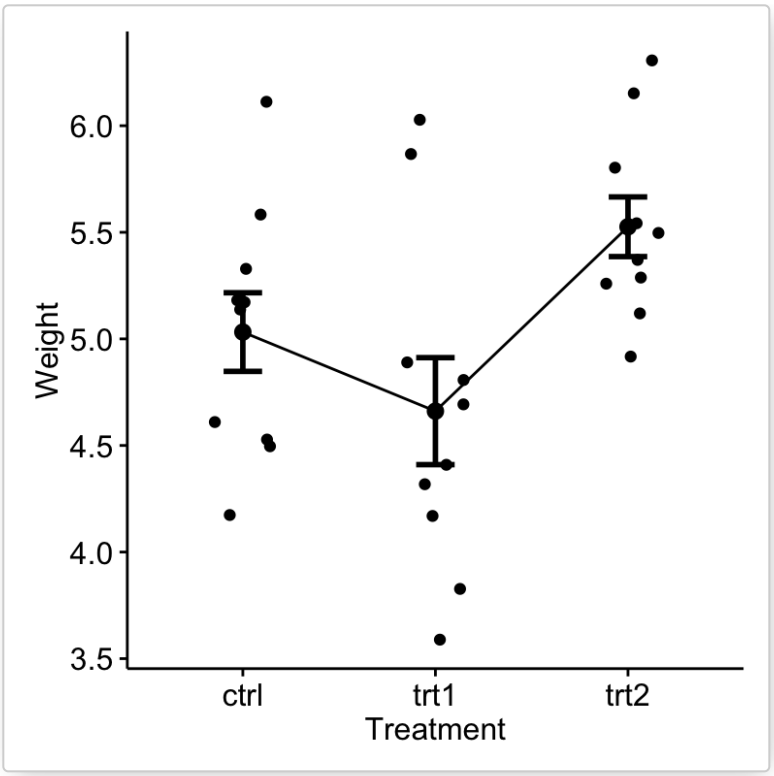
```
install.packages("ggpubr")
```

- Visualize your data with ggpubr:

```
# Box plots
# ++++++++++++++++++++
# Plot weight by group and color by group
library("ggpubr")
ggboxplot(my_data, x = "group", y = "weight",
          color = "group", palette = c("#00AFBB", "#E7B800", "#FC4E07"),
          order = c("ctrl", "trt1", "trt2"),
          ylab = "Weight", xlab = "Treatment")
```




```
# Mean plots
# ++++++++++++++++++++
# Plot weight by group
# Add error bars: mean_se
# (other values include: mean_sd, mean_ci, median_iqr, ....)
library("ggpubr")
ggline(my_data, x = "group", y = "weight",
       add = c("mean_se", "jitter"),
       order = c("ctrl", "trt1", "trt2"),
       ylab = "Weight", xlab = "Treatment")
```



Compute Kruskal-Wallis test

? We want to know if there is any significant difference between the average weights of plants in the 3 experimental conditions.

The test can be performed using the function **kruskal.test**() as follow:

```
kruskal.test(weight ~ group, data = my_data)
```

```
    Kruskal-Wallis rank sum test
data:  weight by group
Kruskal-Wallis chi-squared = 7.9882, df = 2, p-value = 0.01842
```

Interpret

As the p-value is less than the significance level 0.05, we can conclude that there are significant differences between the treatment groups.

Multiple pairwise-comparison between groups

From the output of the Kruskal-Wallis test, we know that there is a significant difference between groups, but we don't know which pairs of groups are different.

It's possible to use the function **pairwise.wilcox.test**() to calculate pairwise comparisons between group levels with corrections for multiple testing.

```
pairwise.wilcox.test(PlantGrowth$weight, PlantGrowth$group,
                 p.adjust.method = "BH")
```

```
    Pairwise comparisons using Wilcoxon rank sum test
data:  PlantGrowth$weight and PlantGrowth$group
     ctrl  trt1
trt1 0.199 -
trt2 0.095 0.027
P value adjustment method: BH
```

The pairwise comparison shows that, only trt1 and trt2 are significantly different ($p < 0.05$).

See also

- Analysis of variance (ANOVA, parametric):
  - One-Way ANOVA Test in R
  - Two-Way ANOVA Test in R
  - MANOVA Test in R: Multivariate Analysis of Variance

Infos

This analysis has been performed using **R software** (ver. 3.2.4).

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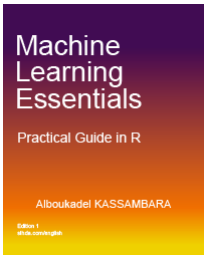

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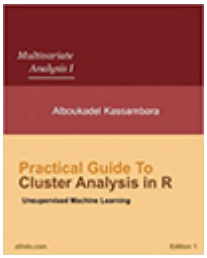

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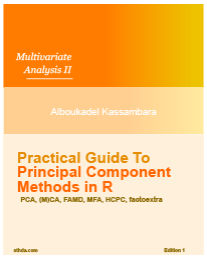

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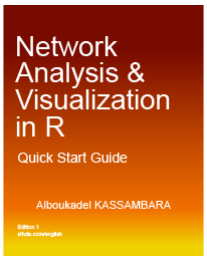

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- Inter-Rater Reliability Essentials: Practical Guide in R by A. Kassambara (Datanovia)

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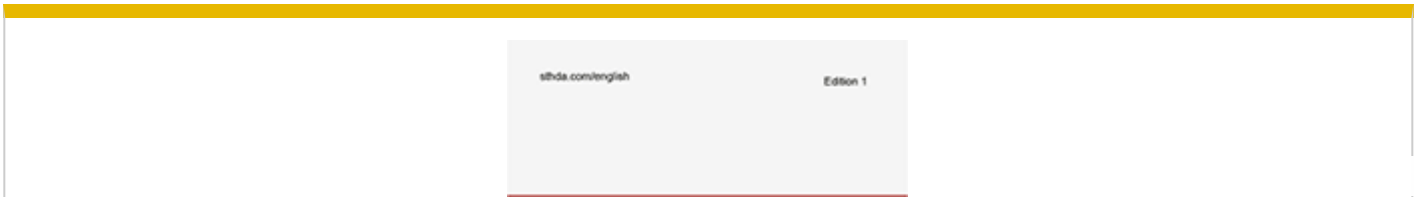

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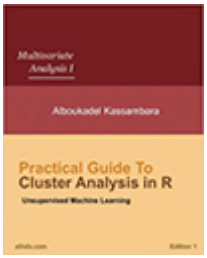

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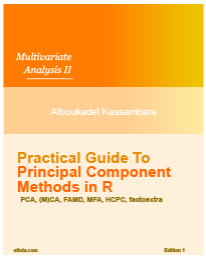

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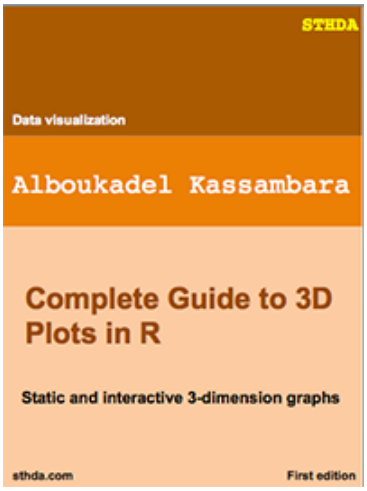

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