Comparing Means in R

Previously, we described the essentials of R programming and provided quick start guides for importing data into **R**. Additionally, we described how to compute descriptive or summary statistics and correlation analysis using R software.

This chapter contains articles describing **statistical tests** to use for **comparing means**. These tests include:

- **T-test**
- **Wilcoxon test**
- **ANOVA test** and
- **Kruskal-Wallis test**

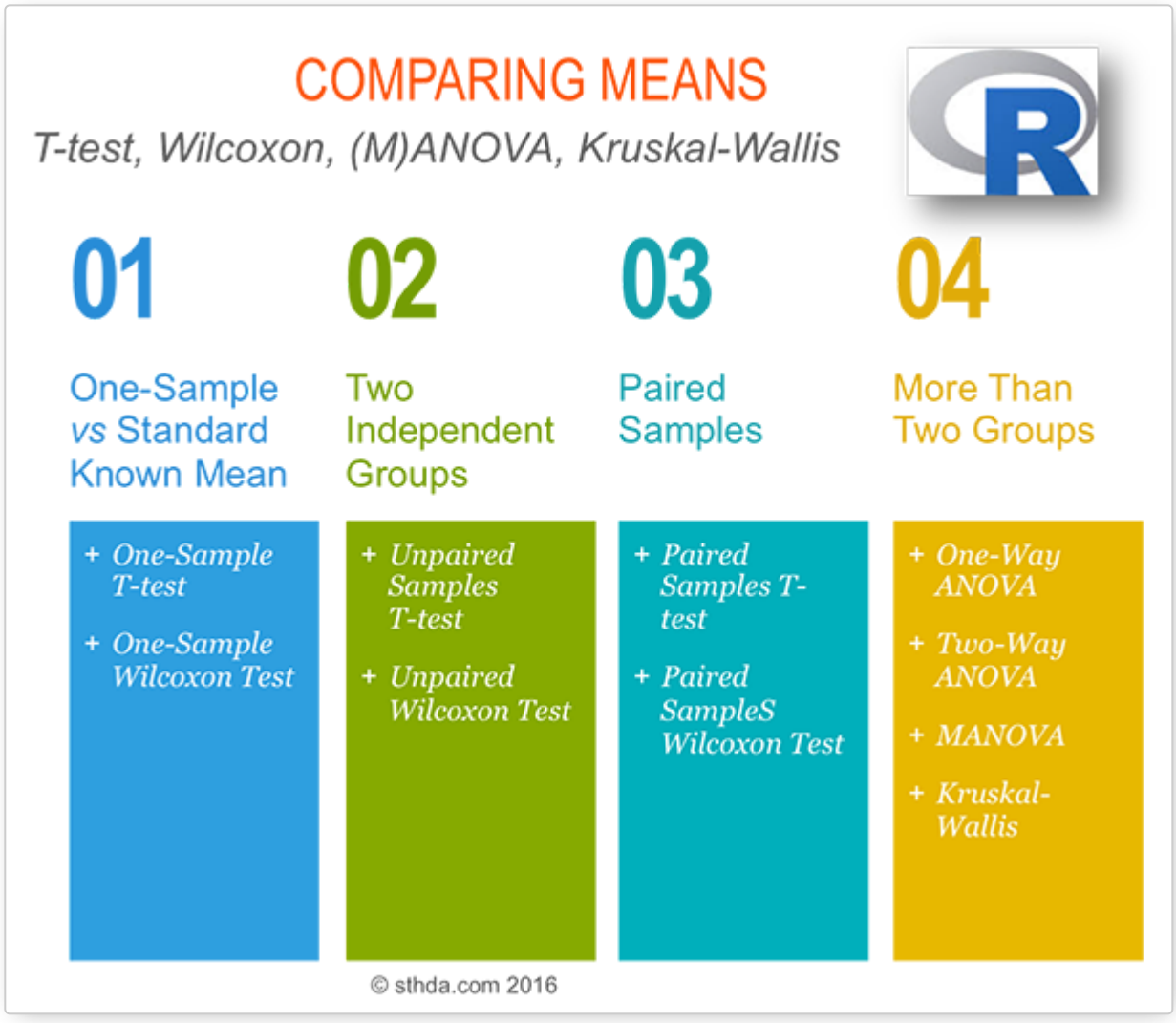
1 How this chapter is organized?

- Comparing one-sample mean to a standard known mean:
  - One-Sample T-test (parametric)
  - One-Sample Wilcoxon Test (non-parametric)
- Comparing the means of two independent groups:

- Unpaired Two Samples T-test (parametric)
- Unpaired Two-Samples Wilcoxon Test (non-parametric)

- Comparing the means of paired samples:
  - Paired Samples T-test (parametric)
  - Paired Samples Wilcoxon Test (non-parametric)

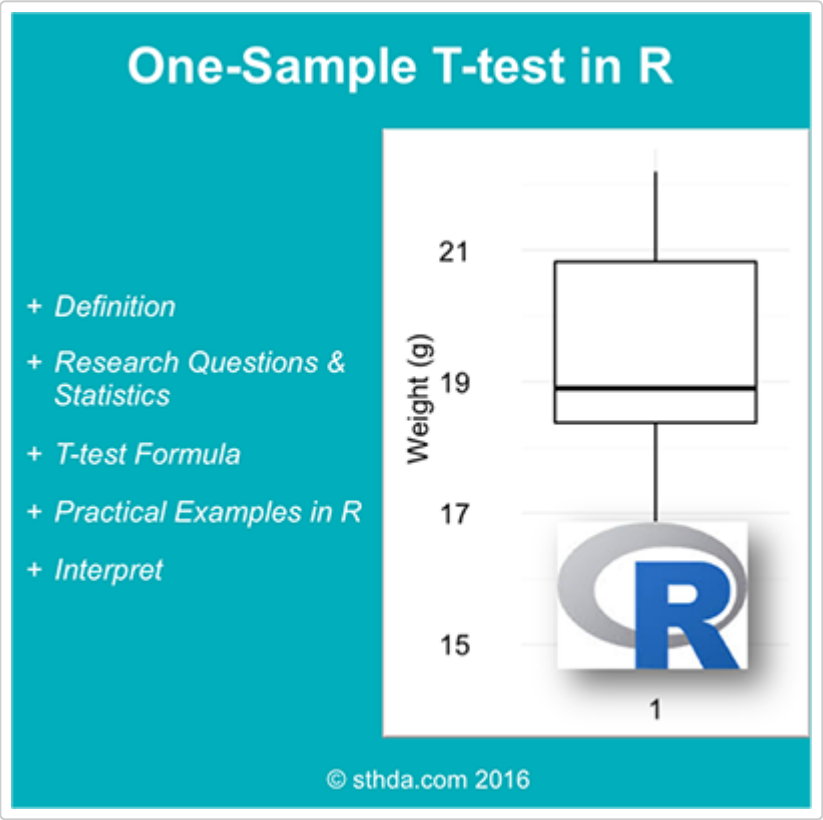
- Comparing the means of more than two groups
  - Analysis of variance (ANOVA, parametric):
    - One-Way ANOVA Test in R
    - Two-Way ANOVA Test in R
    - MANOVA Test in R: Multivariate Analysis of Variance
  - Kruskal-Wallis Test in R (non parametric alternative to one-way ANOVA)



2 Comparing one-sample mean to a standard known mean

2.1 One-sample T-test (parametric)

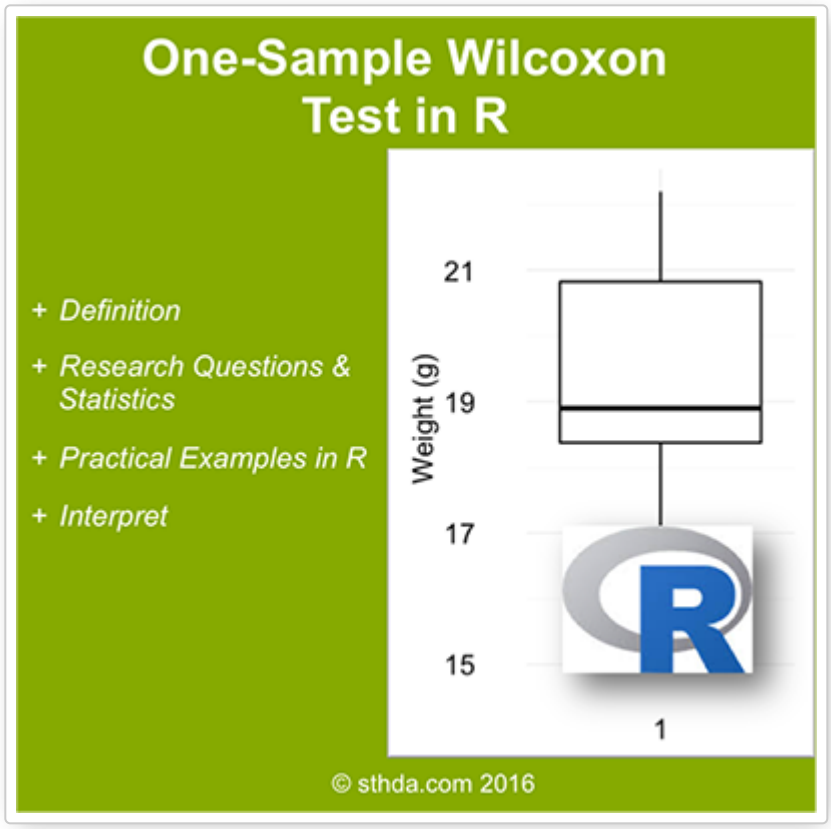
- What is one-sample t-test?
- Research questions and statistical hypotheses
- Formula of one-sample t-test
- Visualize your data and compute one-sample t-test in R
  - R function to compute one-sample t-test
  - Visualize your data using box plots
  - Preliminary test to check one-sample t-test assumptions
  - Compute one-sample t-test
  - Interpretation of the result



Read more: —> One-Sample T-test.

2.2 One-sample Wilcoxon test (non-parametric)

- What's one-sample Wilcoxon signed rank test?
- Research questions and statistical hypotheses
- Visualize your data and compute one-sample Wilcoxon test in R
  - R function to compute one-sample Wilcoxon test
  - Visualize your data using box plots
  - Compute one-sample Wilcoxon test

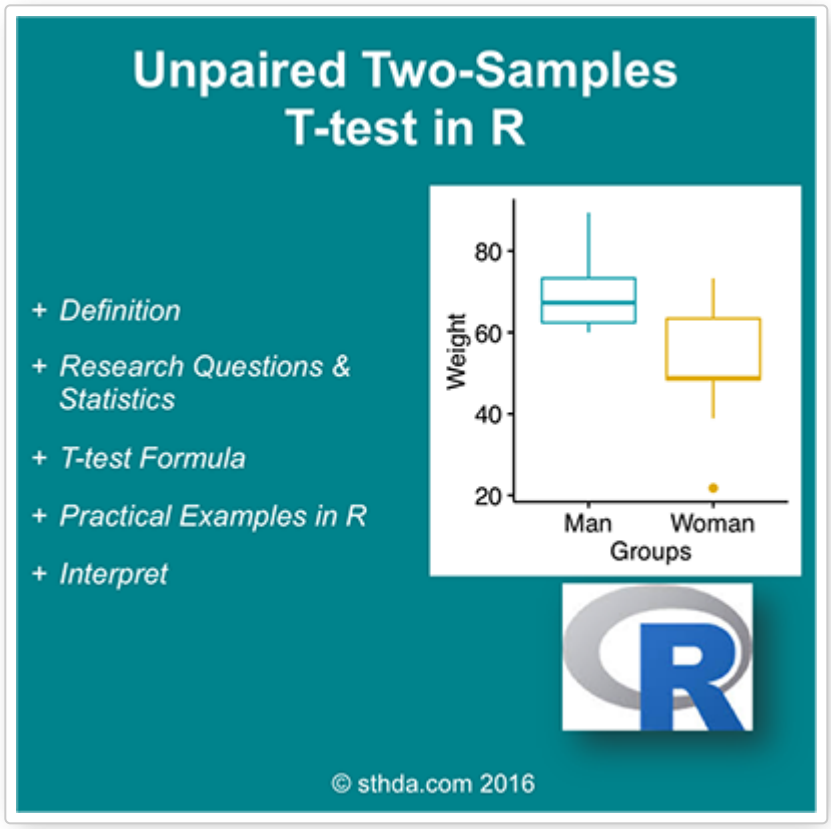


Read more: —> One-Sample Wilcoxon Test (non-parametric).

3 Comparing the means of two independent groups

3.1 Unpaired two samples t-test (parametric)

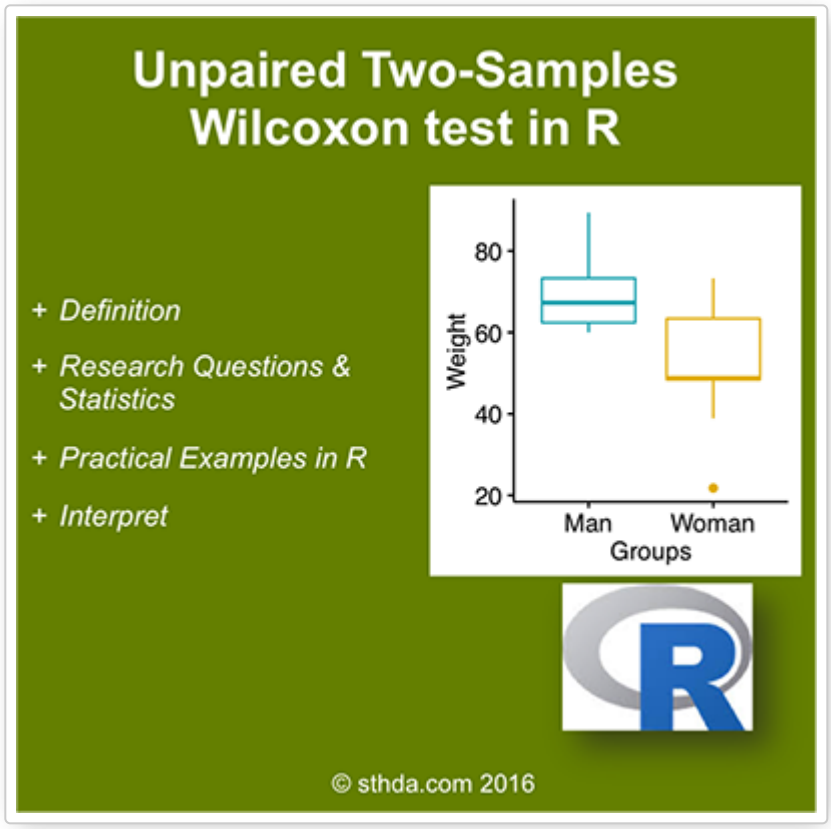
- What is unpaired two-samples t-test?
- Research questions and statistical hypotheses
- Formula of unpaired two-samples t-test
- Visualize your data and compute unpaired two-samples t-test in R
  - R function to compute unpaired two-samples t-test
  - Visualize your data using box plots
  - Preliminary test to check independent t-test assumptions
  - Compute unpaired two-samples t-test
- Interpretation of the result



Read more: —> Unpaired Two Samples T-test (parametric).

3.2 Unpaired two-samples Wilcoxon test (non-parametric)

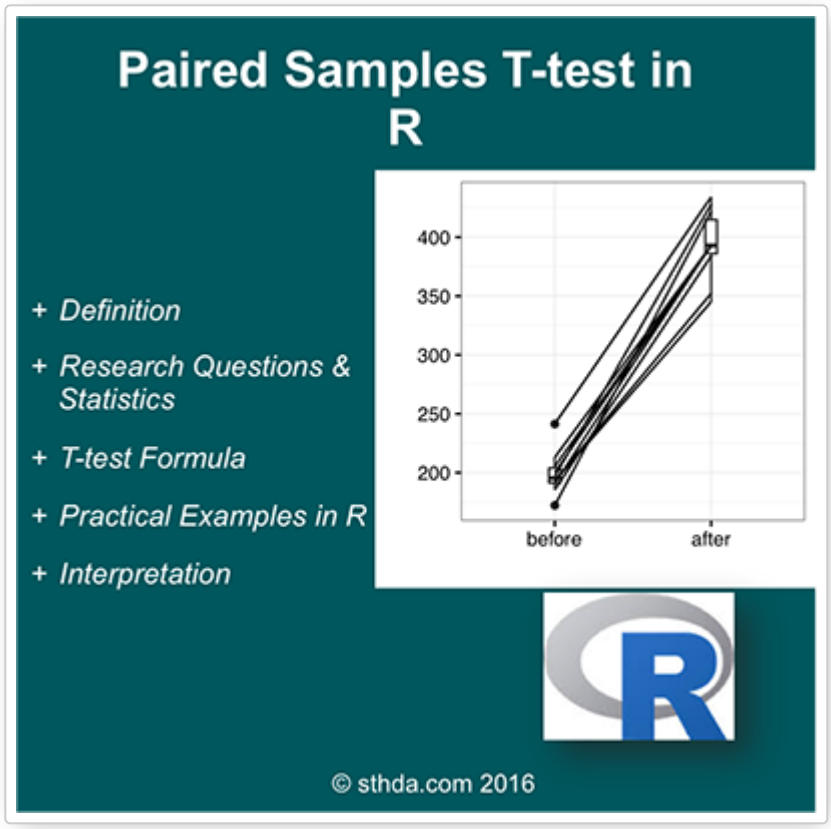
- R function to compute Wilcoxon test
- Visualize your data using box plots
- Compute unpaired two-samples Wilcoxon test



Read more: —> Unpaired Two-Samples Wilcoxon Test (non-parametric).

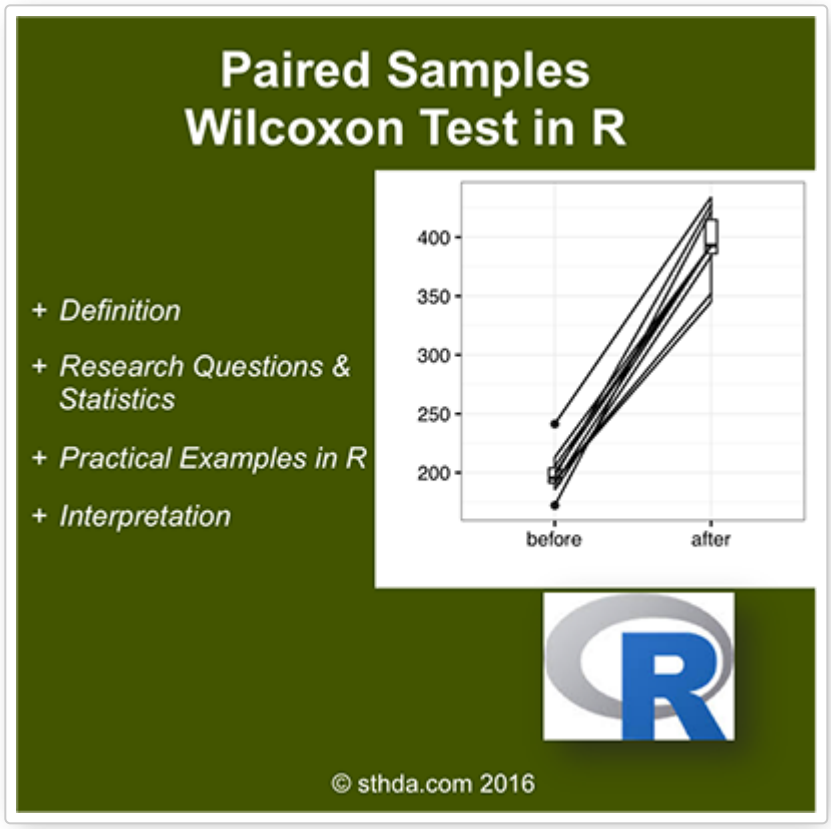
4 Comparing the means of paired samples

4.1 Paired samples t-test (parametric)



Read more: —> Paired Samples T-test (parametric).

4.2 Paired samples Wilcoxon test (non-parametric)



Read more: —> Paired Samples Wilcoxon Test (non-parametric).

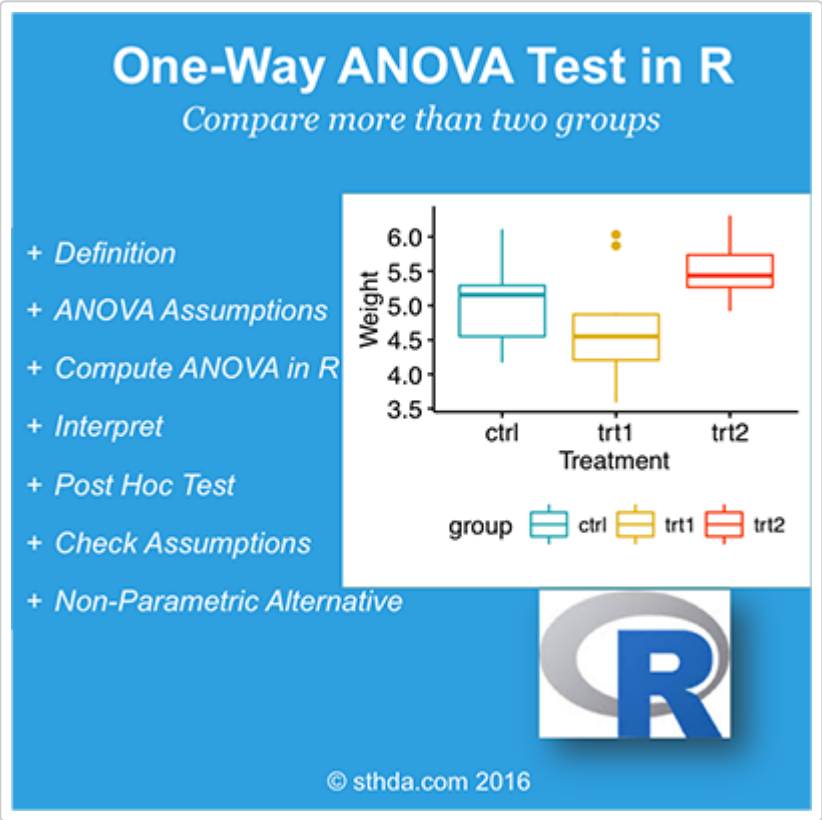
5 Comparing the means of more than two groups

5.1 One-way ANOVA test

An extension of independent two-samples **t-test** for comparing means in a situation where there are more than two groups.

- What is one-way ANOVA test?
- Assumptions of ANOVA test
- How one-way ANOVA test works?
- Visualize your data and compute one-way ANOVA in R
  - Visualize your data
  - Compute one-way ANOVA test
  - Interpret the result of one-way ANOVA tests
  - Multiple pairwise-comparison between the means of groups
    - Tukey multiple pairewise-comparisons
    - Multiple comparisons using multcomp package
    - Pairwise t-test
  - Check ANOVA assumptions: test validity?
    - Check the homogeneity of variance assumption
    - Relaxing the homogeneity of variance assumption
    - Check the normality assumption

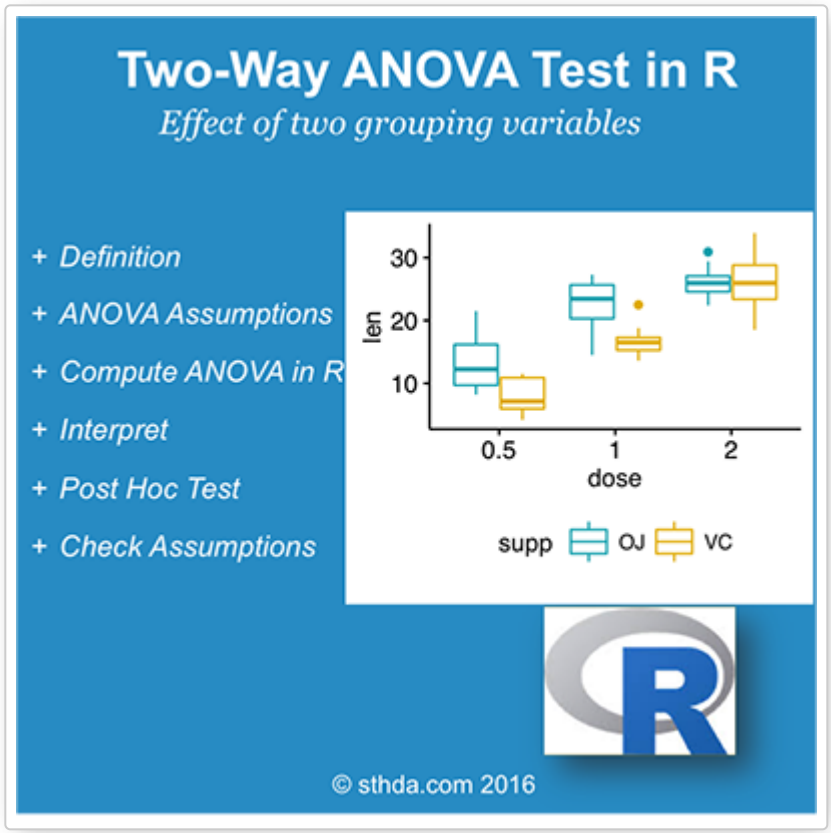
- Non-parametric alternative to one-way ANOVA test



Read more: —> One-Way ANOVA Test in R.

5.2 Two-Way ANOVA test

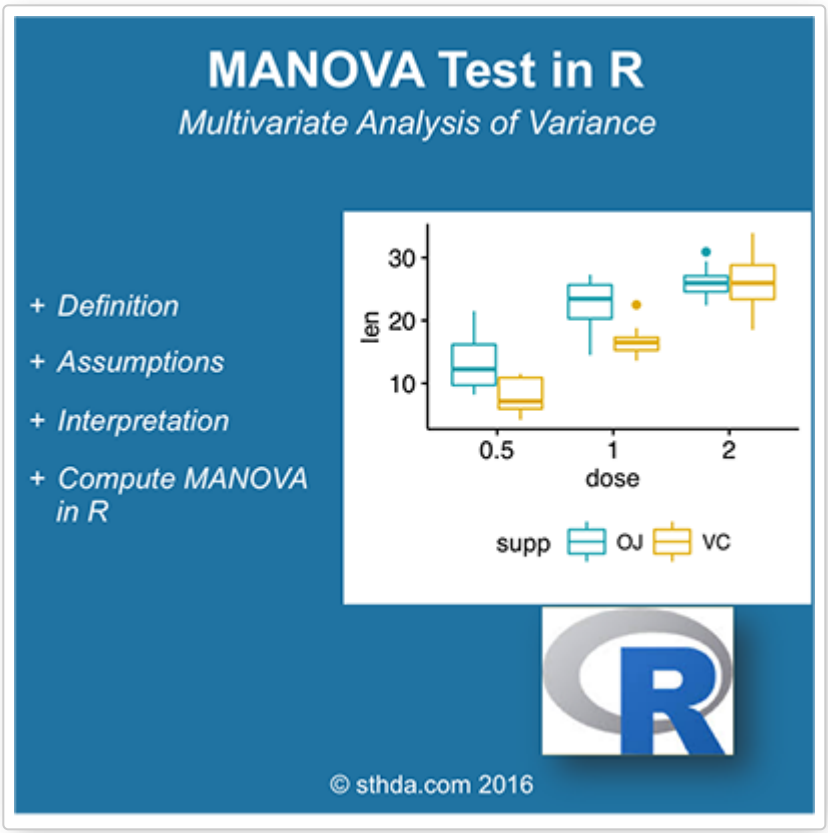
- What is two-way ANOVA test?
- Two-way ANOVA test hypotheses
- Assumptions of two-way ANOVA test
- Compute two-way ANOVA test in R: balanced designs
  - Visualize your data
  - Compute two-way ANOVA test
  - Interpret the results
  - Compute some summary statistics
  - Multiple pairwise-comparison between the means of groups
    - Tukey multiple pairewise-comparisons
    - Multiple comparisons using multcomp package
    - Pairwise t-test
  - Check ANOVA assumptions: test validity?
    - Check the homogeneity of variance assumption
  - Check the normality assumption
- Compute two-way ANOVA test in R for unbalanced designs



Read more: —> Two-Way ANOVA Test in R.

6 MANOVA test: Multivariate analysis of variance

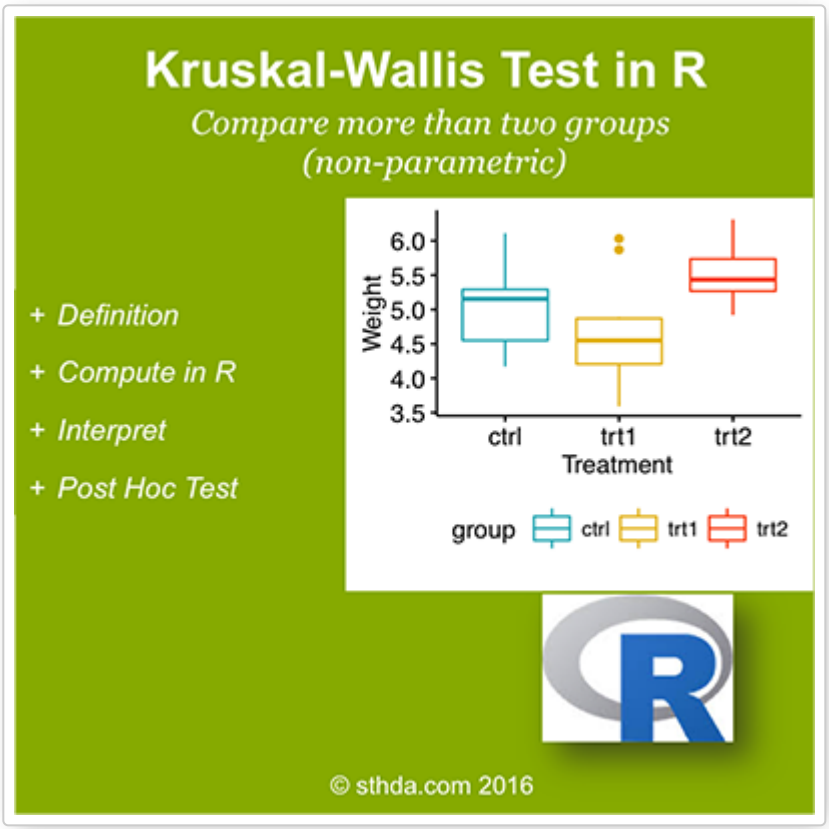
- What is MANOVA test?
- Assumptions of MANOVA
- Interpretation of MANOVA
- Compute MANOVA in R



Read more: —> MANOVA Test in R: Multivariate Analysis of Variance.

7 Kruskal-Wallis test

- What is Kruskal-Wallis test?
- Visualize your data and compute Kruskal-Wallis test in R
  - Visualize the data using box plots
  - Compute Kruskal-Wallis test
  - Multiple pairwise-comparison between groups



Read more: —> Kruskal-Wallis Test in R (non parametric alternative to one-way ANOVA).

8 See also

- R Basics
- Import and Export Data using R
- Preparing and Reshaping Data in R for Easier Analyses
- Data Manipulation in R
- Data visualization
- Descriptive Statistics and Graphics
- Correlation Analyses in R

9 Infos

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

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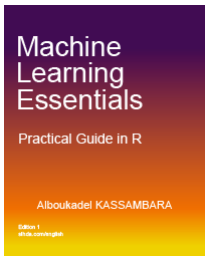

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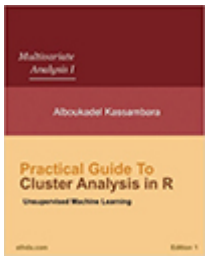

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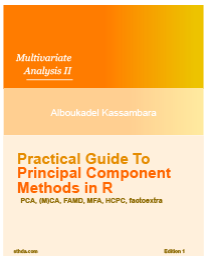

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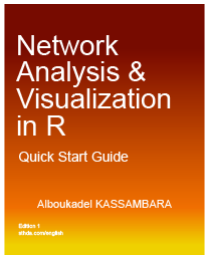

Network Analysis and Visualization in R

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- Course: Machine Learning: Master the Fundamentals by Standford
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- Epidemiology in Public Health Practice by Johns Hopkins University
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Books - Data Science

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Others

- R for Data Science: Import, Tidy, Transform, Visualize, and Model Data by Hadley Wickham & Garrett Grolemund
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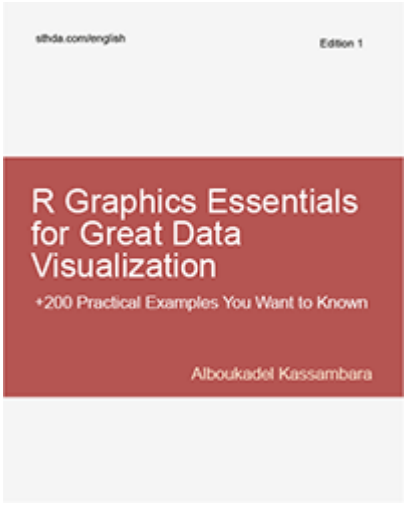

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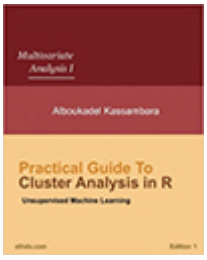

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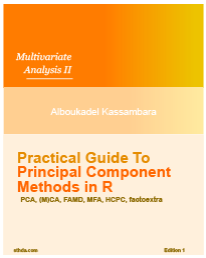

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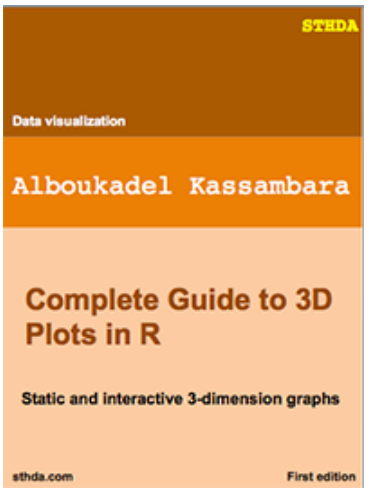

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