

# How can Scheffe's test be performed in R?

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April 22, 2024

## RECOMMENDED CITATION

stats writer (2024). *How can Scheffe's test be performed in R?*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=138249>

Scheffe's test is a statistical method used to determine significant differences between multiple groups in an experiment. In R, this test can be performed by first loading the necessary packages, such as "stats" and "multcomp", and then using the "glht" function to specify the model and desired comparisons. The results can be obtained by using the "summary" function on the output of the "glht" function. It is important to note that Scheffe's test is considered to be a conservative method and should only be used when the assumptions of other tests, such as Tukey's or Bonferroni's, are not met. Careful consideration and understanding of the data and research question are crucial for accurate and valid interpretation of the results obtained from performing Scheffe's test in R.

## Perform Scheffe's Test in R

**A one-way ANOVA is used to determine whether or not there is a statistically significant difference between the means of three or more independent groups.**

**If the overall p-value from the ANOVA table is less than some significance level, then we have sufficient evidence to say that at least one of the means of the groups is different from the others.**

**However, this doesn't tell us *which* groups are different from each other. It simply tells us that not all of the group means are equal.**

**In order to find out exactly which groups are different from each other, we must conduct a post-hoc test that is capable of controlling the family-wise error rate.**

**One of the most commonly used post hoc tests is**

## Scheffe's test.

This tutorial explains how to perform Scheffe's test in R.

Example: Scheffe's Test in R

Suppose a teacher wants to know whether or not three different studying techniques lead to different exam scores among students. To test this, she randomly assigns 10 students to use each studying technique and records their exam scores.

We can use the following steps in R to fit a one-way ANOVA to test for differences in mean exam scores among the three groups and use Scheffe's test to determine exactly which groups are different.

**Step 1: Create the dataset.**

The following code shows how to create a dataset that contains exam scores for all 30 students:

```
#create data frame
data <- data.frame(technique = rep(c("tech1", "tech2",
"tech3"), each = 10),
score = c(76, 77, 77, 81, 82, 82, 83, 84, 85, 89,
```

```
81, 82, 83, 83, 83, 84, 87, 90, 92, 93,  
77, 78, 79, 88, 89, 90, 91, 95, 95, 98))
```

```
#view first six rows of data frame
```

```
head(data)
```

```
technique score
```

```
1 tech1 76
```

```
2 tech1 77
```

```
3 tech1 77
```

```
4 tech1 81
```

```
5 tech1 82
```

```
6 tech1 82
```

**Step 2: Visualize the exam scores for each group.**

The following code shows how to produce boxplots to visualize the distribution of exam scores for each group:

```
boxplot(score ~ technique,
```

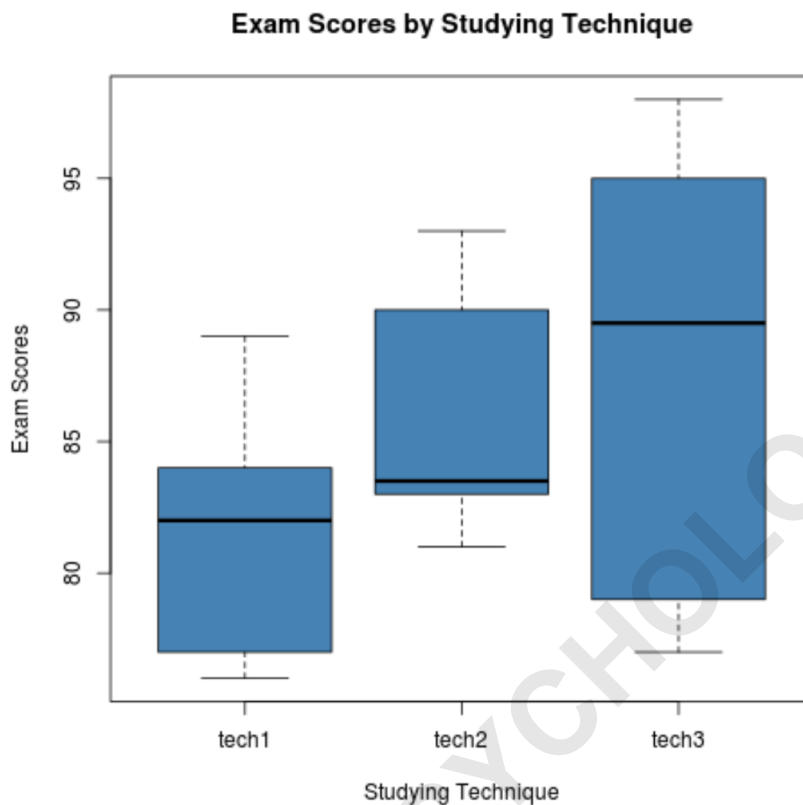
```
data = data,
```

```
main = "Exam Scores by Studying Technique",
```

```
xlab = "Studying Technique",
```

```
ylab = "Exam Scores",
```

```
col = "steelblue",  
border = "black")
```



**Step 3: Perform a one-way ANOVA.**

```
#fit the one-way ANOVA model
```

```
model <- aov(score ~ technique, data = data)
```

```
#view model output
```

```
summary(model)
```

```
Df Sum Sq Mean Sq F value Pr(>F)
```

**technique 2 211.5 105.73 3.415 0.0476 \***

**Residuals 27 836.0 30.96**

**---**

**Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1**

Since the overall p-value (0.0476) is less than .05, this is an indication that each group does not have the same average exam score.

Next, we will perform Scheffe's test to determine which groups are different.

**Step 4: Perform Scheffe's Test.**

To perform Scheffe's test, we'll use the `ScheffeTest()` function from the DescTools package.

The following code shows how to use this function for our example:

```
#load DescTools package
```

```
library(DescTools)
```

```
#perform Scheffe's test
```

```
ScheffeTest(model)
```

## Posthoc multiple comparisons of means : Scheffe Test 95% family-wise confidence level

**\$technique**

**diff lwr.ci upr.ci pval**

**tech2-tech1 4.2 -2.24527202 10.645272 0.2582**

**tech3-tech1 6.4 -0.04527202 12.845272 0.0519 .**

**tech3-tech2 2.2 -4.24527202 8.645272 0.6803**

**---**

**Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1**

**The way to interpret the output is as follows:**

**The mean difference in exam scores between technique 2 and technique 1 is 4.2. The corresponding p-value for the mean difference is .2582.**

**The mean difference in exam scores between technique 3 and technique 1 is 6.4. The corresponding p-value for the mean difference is .0519.**

**The mean difference in exam scores between technique 3 and technique 2 is 2.2. The corresponding p-value for the mean difference is .6803.**

**Depending on the significance level we decide to use,**

**the only two groups that seem to be statistically significantly different are technique 3 and technique 1.**

**How to Conduct a One-Way ANOVA in R**

**How to Perform Tukey's Test in R**

**How to Perform a Bonferroni Correction in R**

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