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How to Perform Tukey's Test in Python

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.

One of the most commonly used post hoc tests is **Tukey's Test**, which allows us to make pairwise comparisons between the means of each group while controlling for the family-wise error rate.

This tutorial provides a step-by-step example of how to perform Tukey's Test in Python.

Step 1: Load Necessary Packages and Functions

First, we'll load the necessary packages and functions in Python:

```
import pandas as pd
import numpy as np
from scipy.stats import f_oneway
from statsmodels.stats.multicomp import pairwise_tukeyh
sd
```

Step 2: Fit the ANOVA Model

The following code shows how to create a fake dataset with three groups (A, B, and C) and fit a one-way ANOVA model to the data to determine if the mean values for each group are equal:

```
#enter data for three groups
a = [85, 86, 88, 75, 78, 94, 98, 79, 71, 80]
b = [91, 92, 93, 90, 97, 94, 82, 88, 95, 96]
c = [79, 78, 88, 94, 92, 85, 83, 85, 82, 81]

#perform one-way ANOVA
f_oneway(a, b, c)

F_onewayResult(statistic=5.167774552944481, pvalue=0.01
2582197136592609)
```

We can see that the overall p-value from the ANOVA table is **0.01258**.

Since this is less than .05, we have sufficient evidence to say that the mean values across each group are not equal.

Thus, we can proceed to perform Tukey's Test to determine exactly which group means are different.

Step 3: Perform Tukey's Test

To perform Tukey's test in Python, we can use the **pairwise_tukeyhsd()** function from the **statsmodels** library:

```
#create DataFrame to hold data
df = pd.DataFrame({'score': [85, 86, 88, 75, 78, 94, 98
, 79, 71, 80,
                             91, 92, 93, 90, 97, 94, 82, 8
                             79, 78, 88, 94, 92, 85, 83, 8
                   'group': np.repeat(['a', 'b', 'c'],
repeats=10)})

# perform Tukey's test
tukey = pairwise_tukeyhsd(endog=df['score'],
                          groups=df['group'],
                          alpha=0.05)

#display results
print(tukey)

 Multiple Comparison of Means - Tukey HSD, FWER=0.05
=====================================================
group1 group2 meandiff p-adj   lower    upper  reject
-----------------------------------------------------
     a      b      8.4 0.0158   1.4272 15.3728   True
     a      c      1.3 0.8864  -5.6728  8.2728  False
     b      c     -7.1 0.0453 -14.0728 -0.1272   True
-----------------------------------------------------
```

Here's how to interpret the output:

- P-value for the difference in means between a and b: **.0158**
- P-value for the difference in means between a and c: **.8864**
- P-value for the difference in means between b and c: **.0453**

Thus, we would conclude that there is a statistically significant difference between the means of groups *a* and *b* and groups *b* and *c*, but not a statistically significant difference between the means of groups *a* and *c*.

Additional Resources

How to Perform a One-Way ANOVA in Python
How to Perform a Two-Way ANOVA in Python
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