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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_tukeyhsd
```

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=0.012582197136592609)
```

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, 88, 95, 96,
                             79, 78, 88, 94, 92, 85, 83, 85, 82, 81],
                  '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](#)
[How to Perform a Repeated Measures ANOVA in Python](#)

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