

Hypothesis Testing using ANOVA-Test

Exp : 14

Date: 23-10-2025

Aim:

To compare the growth rates of plants under three different fertilizer treatments (A, B, and C) to determine if there is a **significant difference** in their mean growth.

Algorithm:

1. **Null Hypothesis (H_0):** The mean growth rates of plants under all three fertilizer treatments are equal.
2. **Alternative Hypothesis (H_1):** At least one pair of mean growth rates of plants under different fertilizer treatments are not equal.

3. Samples:

- o Measure the growth (in centimeters) of 25 plants under Treatment A.
- o Measure the growth (in centimeters) of 25 plants under Treatment B.
- o Measure the growth (in centimeters) of 25 plants under Treatment C.

4. **ANOVA:** Conduct a one-way ANOVA to compare the mean growth rates of plants across the three fertilizer treatments.

5. **Decision Rule:** Use a significance level of $\alpha = 0.05$.

Code:

```
import numpy as np

import scipy.stats as stats

from statsmodels.stats.multicomp import pairwise_tukeyhsd # Imported for post-hoc analysis

np.random.seed(42)

n_plants = 25

growth_A = np.random.normal(loc=10, scale=2, size=n_plants)

growth_B = np.random.normal(loc=12, scale=3, size=n_plants)

growth_C = np.random.normal(loc=15, scale=2.5, size=n_plants)

all_data = np.concatenate([growth_A, growth_B, growth_C])

treatment_labels = ['A'] * n_plants + ['B'] * n_plants + ['C'] * n_plants

f_statistic, p_value = stats.f_oneway(growth_A, growth_B, growth_C)

print("Treatment A Mean Growth:", np.mean(growth_A))

print("Treatment B Mean Growth:", np.mean(growth_B))

print("Treatment C Mean Growth:", np.mean(growth_C))

print()

print(f"F-Statistic: {f_statistic:.4f}")

print(f"P-Value: {p_value:.4f}")

alpha = 0.05

if p_value < alpha:

    print("Reject the null hypothesis: There is a significant difference in mean growth rates among the three treatments.")

    # Post-hoc analysis (Tukey's HSD)

    tukey_results = pairwise_tukeyhsd(all_data, treatment_labels, alpha=0.05)

    print("\nTukey's HSD Post-hoc Test:")

    print(tukey_results)

else:

    print("Fail to reject the null hypothesis: There is no significant difference in mean growth rates among the three treatments.")
```

Output:

Treatment A Mean Growth: 9.672983882683818

Treatment B Mean Growth: 11.137680744437432

Treatment C Mean Growth: 15.265234904828972

F-Statistic: 36.1214

P-Value: 0.0000

Reject the null hypothesis: There is a significant difference in mean growth rates among the three treatments.

Tukey's HSD Post-hoc Test:

Multiple Comparison of Means - Tukey HSD, FWER=0.05

group1 group2 meandiff p-adj lower upper reject

A B 1.4647 0.1691 -0.4285 3.3578 False

A C 5.5923 0.001 3.7005 7.4842 True

B C 4.1276 0.001 2.2356 6.0195 True

Result:

The P-Value (0.0000) is less than α (0.05). We **Reject the Null Hypothesis**. There is a significant difference in mean growth rates among the three treatments. Tukey's HSD showed that Treatment C is significantly different from A and B, which are not significantly different from each other.