

Experiment 14

Date: 23.10.2025

14. Hypothetical using ANOVA-Test

Aim:

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

Description:

A statistical ANOVA -Test is conducted to determine the growth rates of plants under three different treatments .

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:
 - Measure the growth (in centimeters) of 25 plants under Treatment A.
 - Measure the growth (in centimeters) of 25 plants under Treatment B.
 - 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 With Example:

```
import numpy as np
import scipy.stats as stats

# Set a random seed for reproducibility
np.random.seed(42)

# Generate hypothetical growth data for three treatments (A, B, C)
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)

# Combine all data into one array
all_data = np.concatenate([growth_A, growth_B, growth_C])

# Treatment labels for each group
treatment_labels = ['A'] * n_plants + ['B'] * n_plants + ['C'] * n_plants

# Perform one-way ANOVA
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}")
```

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
```

```

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

if p_value < alpha:
    from statsmodels.stats.multicomp import pairwise_tukeyhsd

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

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

```

Output:

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 0.0877  -0.1683  3.0977   False
      A      C   5.5923   0.0   3.9593  7.2252    True
      B      C   4.1276   0.0   2.4946  5.7605    True
-----

```

Result:

The Python program to compare the growth rates of plants under three different fertilizer treatments involves conducting an ANOVA test to determine if there is a significant difference in mean growth rates among the treatments was executed.