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.

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 $\alpha = 0.05$.

Program:

```
[18]: import numpy as np
      import scipy.stats as stats
```

```
[19]: 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)
```

```
[20]: all_data = np.concatenate([growth_A, growth_B, growth_C])
      treatment_labels = ['A'] * n_plants + ['B'] * n_plants + ['C'] * n_plants
```

```
[21]: f_statistic, p_value = stats.f_oneway(growth_A, growth_B, growth_C)
      alpha = 0.05
```

```
[22]: 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(f"F-Statistic: {f_statistic:.4f}")
      print(f"P-Value: {p_value:.4f}")

      if p_value < alpha:
          print("Reject the null hypothesis: There is a significant difference in mean growth rates among the three treatments.")
          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)
      else:
          print("Fail to reject the null hypothesis: There is no significant difference in mean growth rates among the three treatments.")
```

```
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 0.0877 -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:

Thus, the Python code to perform one-way ANOVA for comparing plant growth under three different fertilizer treatments is successfully executed.