One-Way ANOVA

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A **one-way ANOVA** (Analysis of Variance) is a statistical test used to determine whether there are **significant differences between the means of three or more independent groups**.

Purpose
It helps answer the question:
"Do at least one of these groups differ significantly in their average value?"
Unlike a t-test (which compares two groups), **ANOVA** can handle **multiple groups** simultaneously.

Example

Example Scenario

Suppose you're comparing average exam scores across **three different teaching methods**:

- Method A
- Method B
- Method C

You want to know: *Is there a significant difference in average scores among these methods?*

Hypothesis

Hypotheses

Null Hypothesis (H_0):
All group means are **equal**.

$$H_0: \mu_1 = \mu_2 = \mu_3 = \cdots = \mu_k$$

Alternative Hypothesis (H_1):
At least **one group mean is different**.

$$H_a: \text{At least one } \mu_i \neq \mu_j$$

F-stat & p-value

ANOVA compares:

Between-group variability (differences between group means)
Within-group variability (differences within each group)
If the between-group variability is large relative to the within-group variability, the test may conclude that the group means are not all equal.

Output

The test produces an **F-statistic** and a **p-value**:
If **p < 0.05**, you reject the null hypothesis → at least one group is different.
If **p ≥ 0.05**, you fail to reject the null → no significant difference.