Cronbach's Alpha

# Introduction

Cronbach's Alpha is a measure of internal consistency, which indicates how closely related a set of items are as a group. It is used extensively in psychology, education, and social sciences to assess the reliability of questionnaires, tests, and other scales.

# Formula

The formula for Cronbach's Alpha is given by:

α = N / (N-1) \* (1 - Σ(σ\_i^2) / σ\_total^2)

Where:  
- N is the number of items.  
- σ\_i^2 is the variance of each item.  
- σ\_total^2 is the total variance of the sum of all items.

# Interpretation

Cronbach's Alpha values typically range between 0 and 1, with higher values indicating higher internal consistency.

Interpretation of α values:  
- α ≥ 0.9: Excellent internal consistency  
- 0.7 ≤ α < 0.9: Good internal consistency  
- 0.6 ≤ α < 0.7: Acceptable internal consistency  
- α < 0.6: Poor internal consistency, revision needed

# Applications

Cronbach's Alpha is used in various fields to evaluate the reliability of measurement instruments:  
- \*\*Questionnaire Validation:\*\* Ensuring that a set of survey questions consistently measure the same construct.  
- \*\*Educational Assessments:\*\* Assessing the reliability of exams or tests in measuring student performance.  
- \*\*Psychometric Tools:\*\* Evaluating the consistency of psychological measures such as personality tests.

# Python Implementation Example

Below is a Python example of calculating Cronbach's Alpha:

import numpy as np  
from scipy.stats import pearsonr  
  
def cronbach\_alpha(items\_scores):  
 items\_scores = np.array(items\_scores)  
 item\_vars = items\_scores.var(axis=1, ddof=1)  
 total\_var = items\_scores.sum(axis=0).var(ddof=1)  
 n\_items = items\_scores.shape[0]  
  
 return (n\_items / (n\_items - 1)) \* (1 - (item\_vars.sum() / total\_var))  
  
# Example Data (3 items, 5 respondents)  
data = [  
 [4, 2, 5, 3, 5],  
 [5, 3, 4, 4, 4],  
 [4, 2, 4, 3, 4]  
]  
  
alpha = cronbach\_alpha(data)  
print(f"Cronbach's Alpha: {alpha:.3f}")