



Research Methodology & Statistics

A Comprehensive Analytic Review for UGC NET Management & Commerce

- Concept-Driven | Pedagogy-Focused | Revision Marathon •

The Spectrum of Research: Goals and Logic

Goal-Oriented Classification

Fundamental (Pure/Basic)

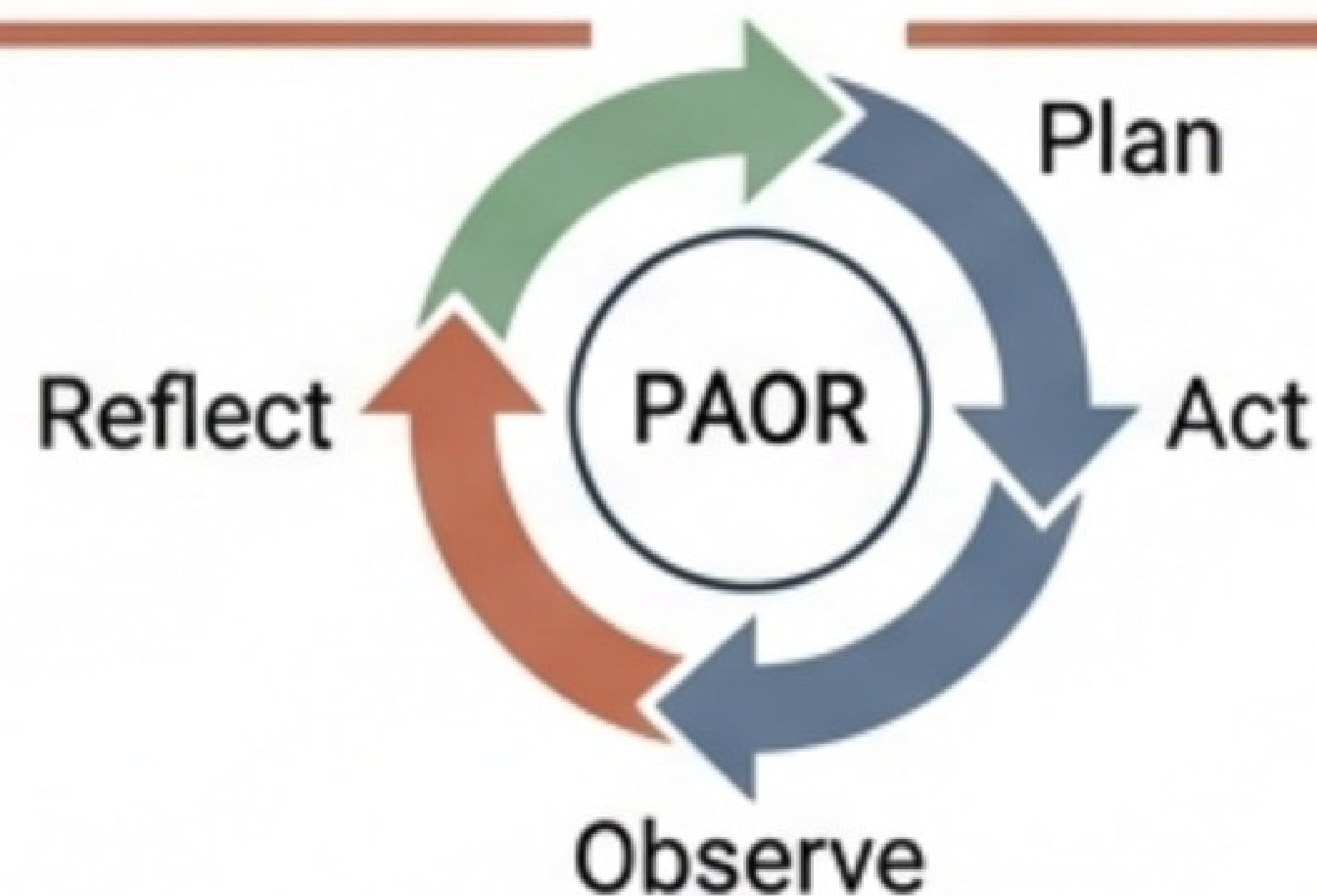
Knowledge for knowledge's sake.
Theory building. Curiosity-driven.

Applied

Solution finding. Practical application of
theory to real-life problems.

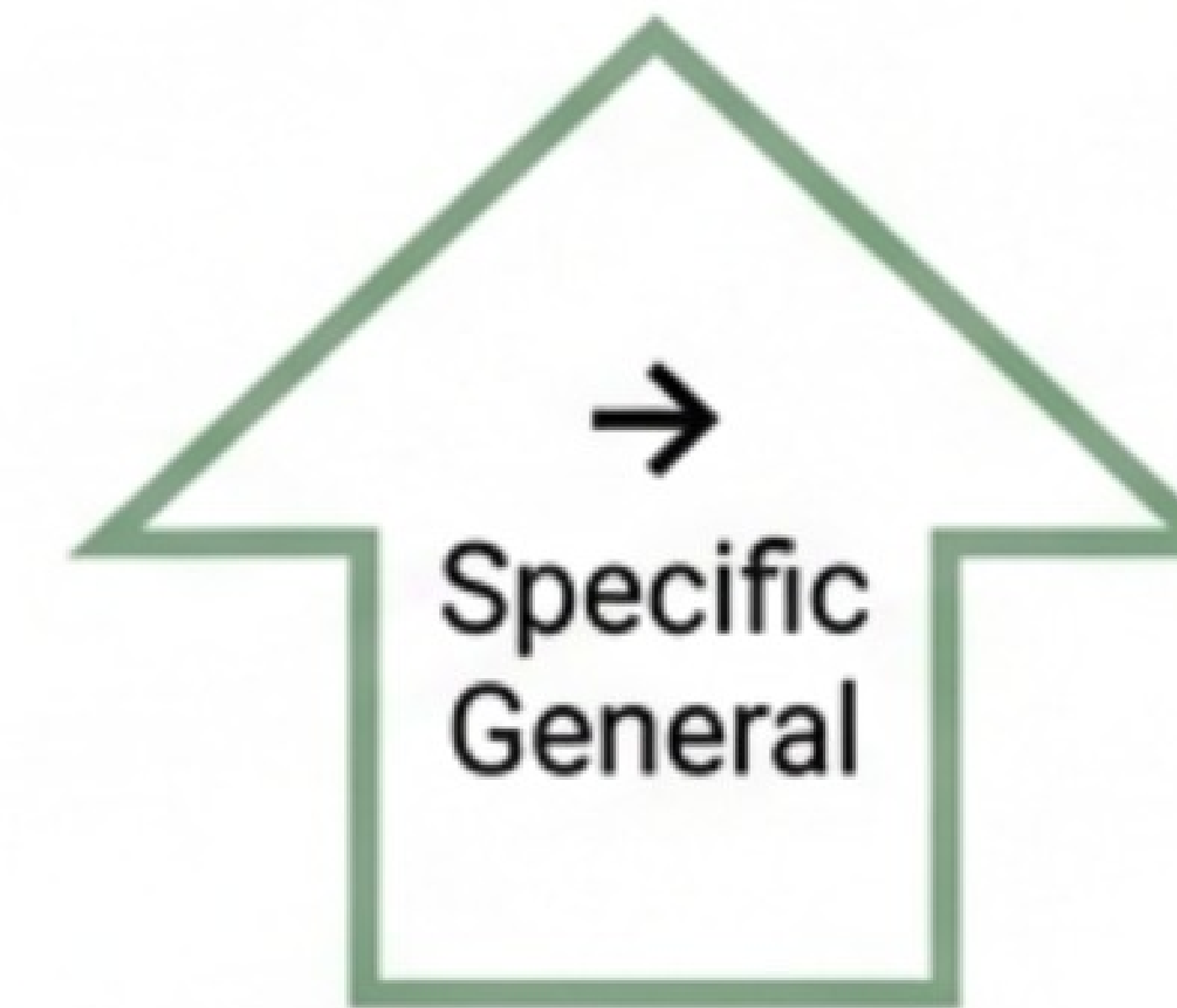
Action Research

Cyclic research for local/institutional
improvement (Kurt Lewin).



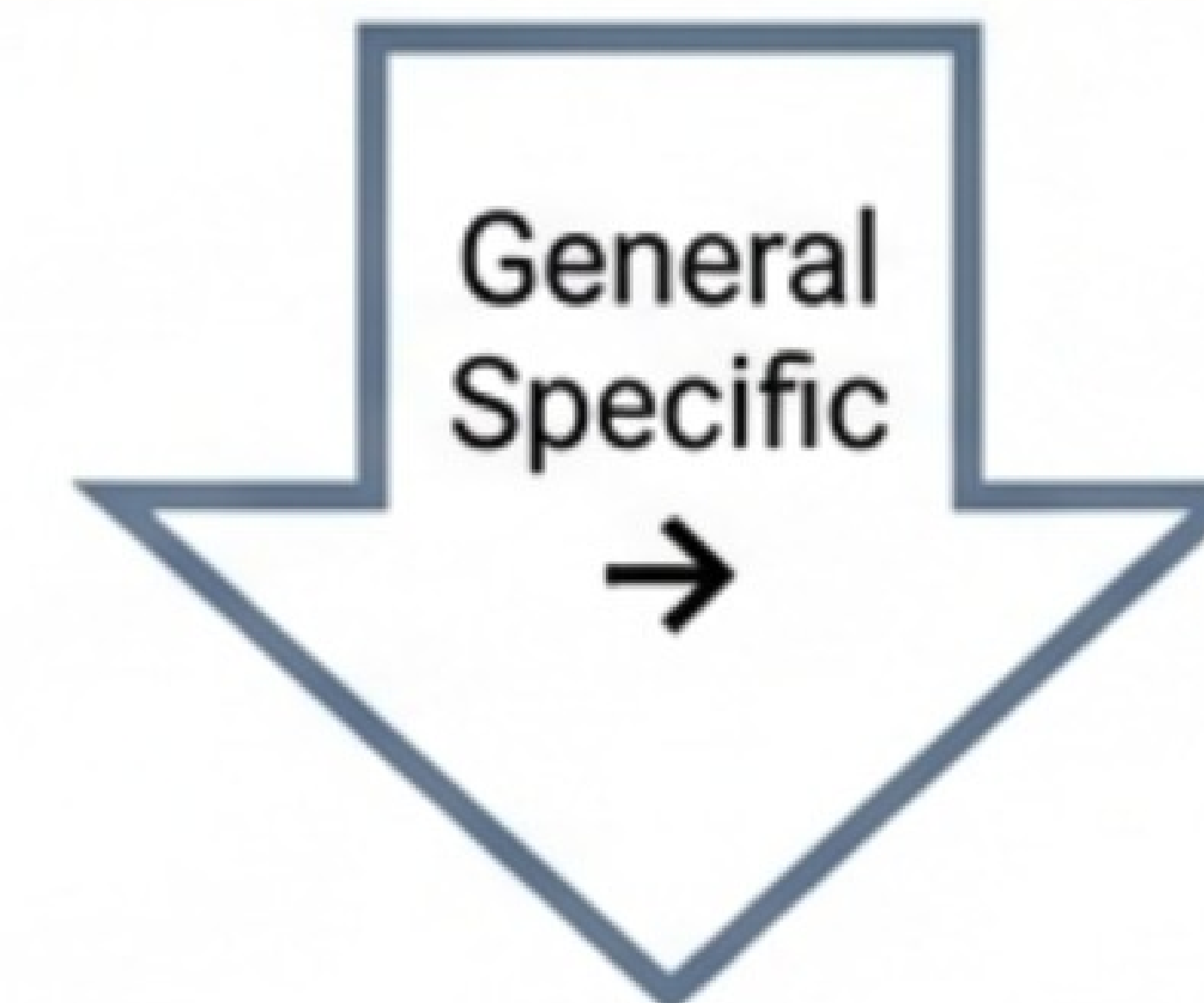
Logic-Oriented Classification

Inductive (Qualitative)



Theory Generation.
Subjective.

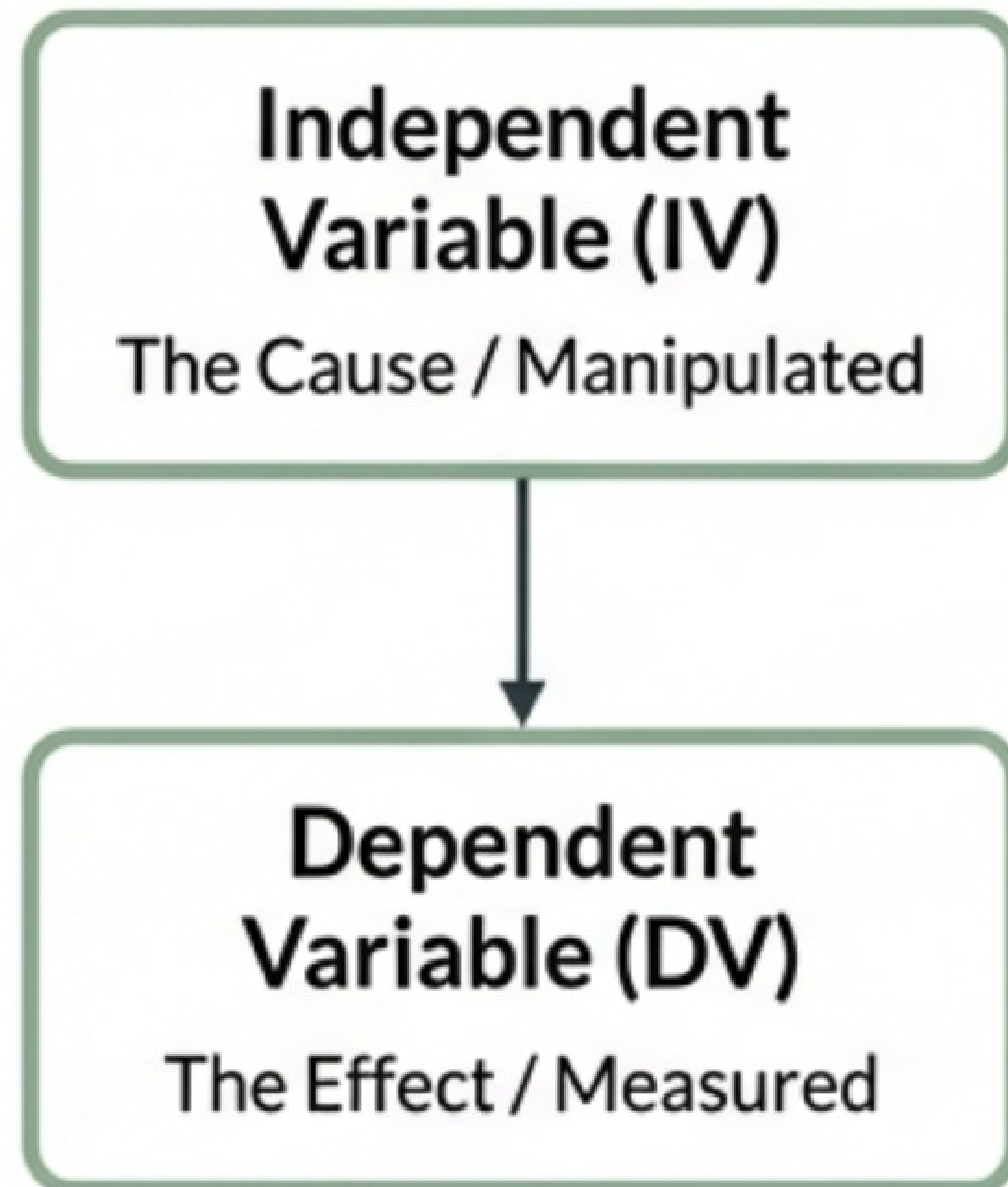
Deductive (Quantitative)



Theory Testing.
Objective.
(Mnemonic: **DGP** -
Deductive, General,
Particular).

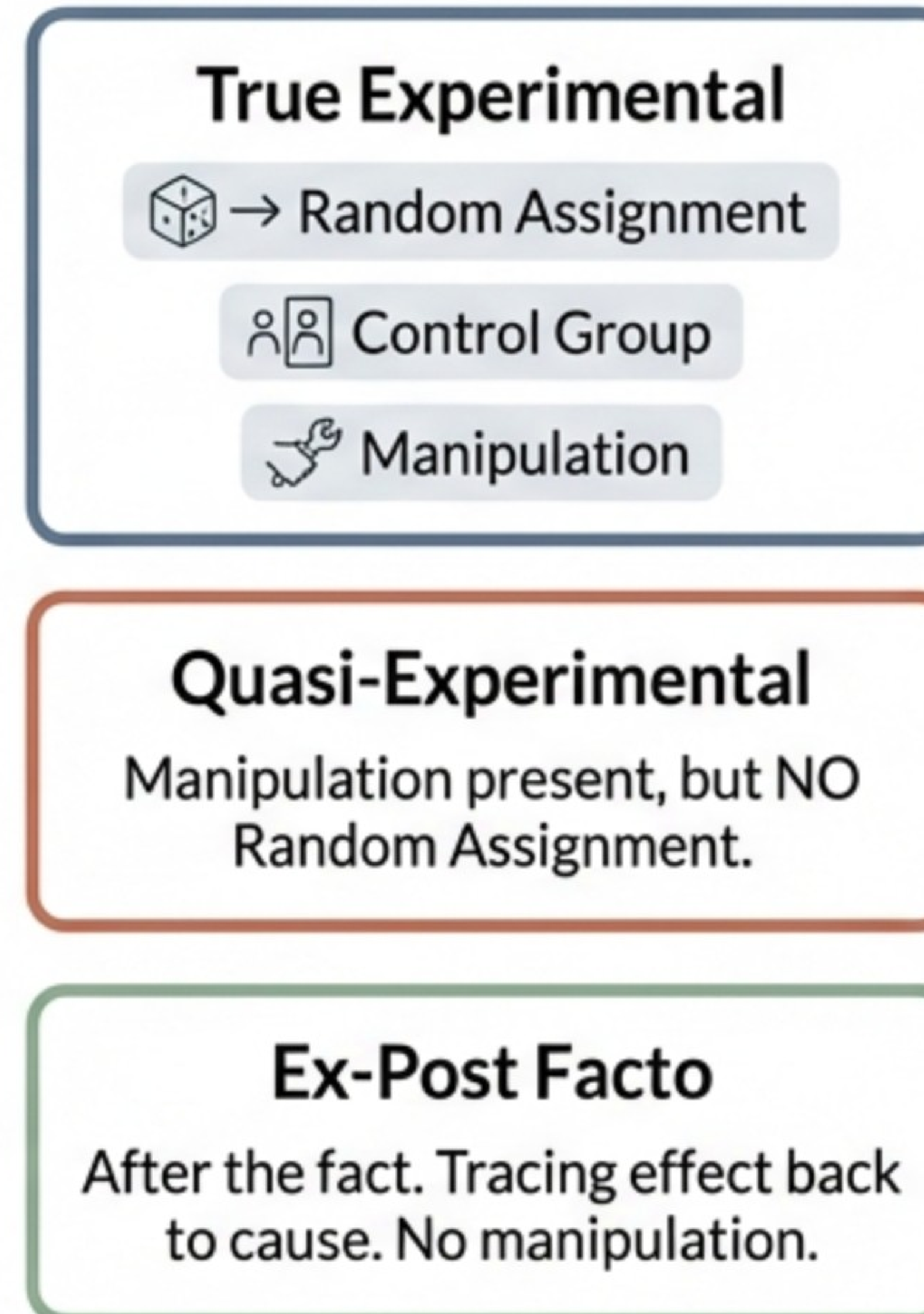
Experimental Design & Variable Control

The Variables

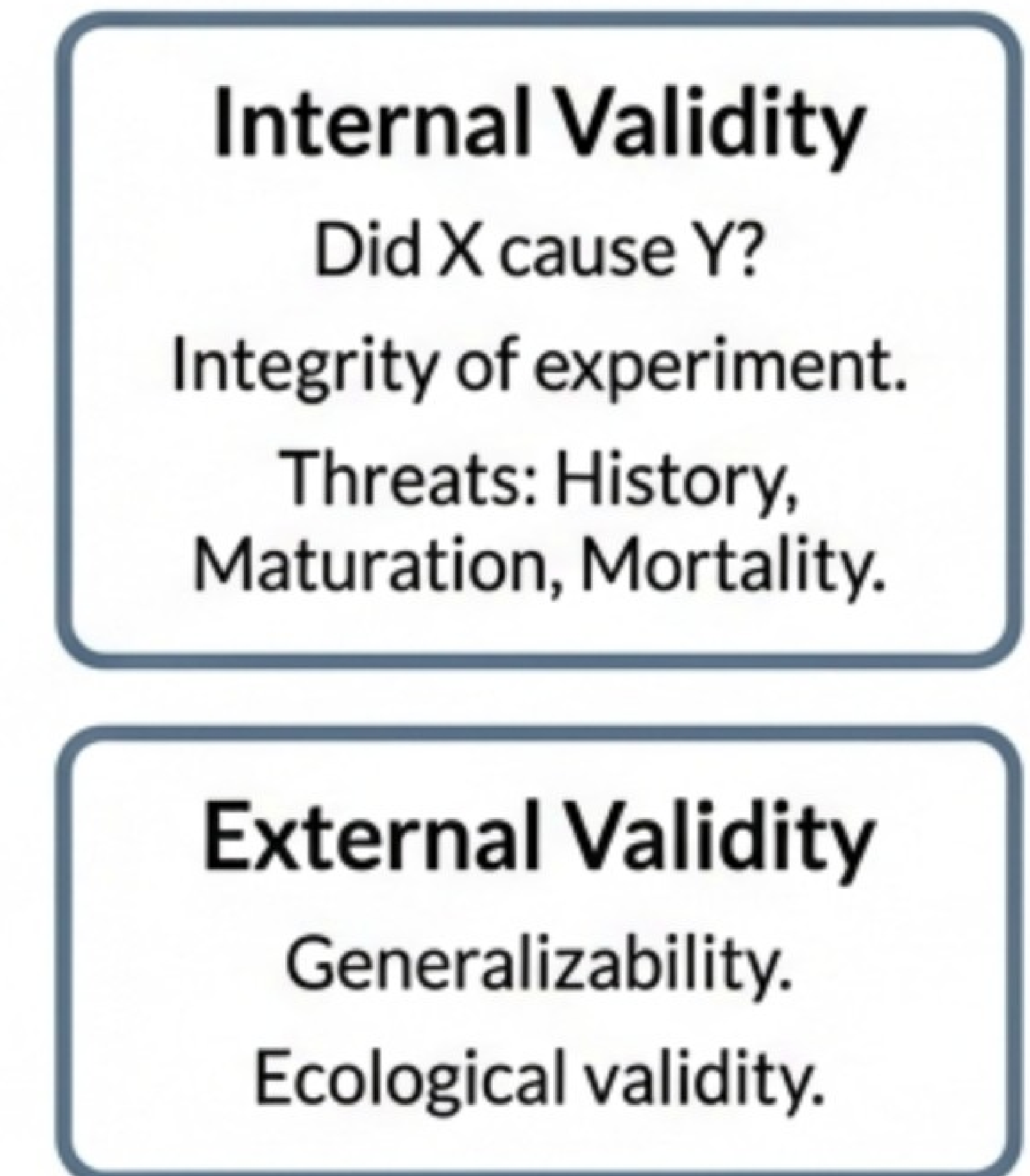


Experimental Designs

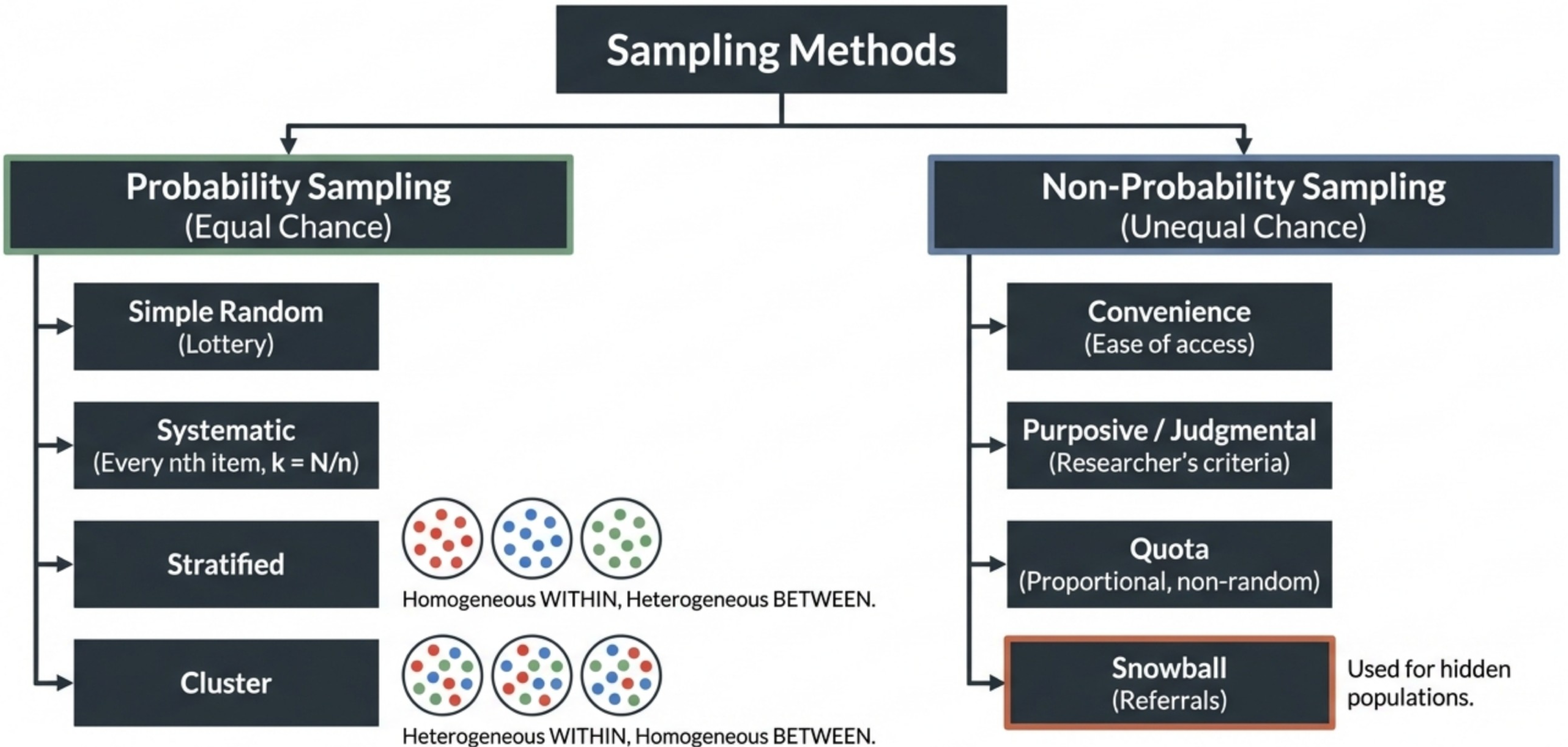
Experimental Designs



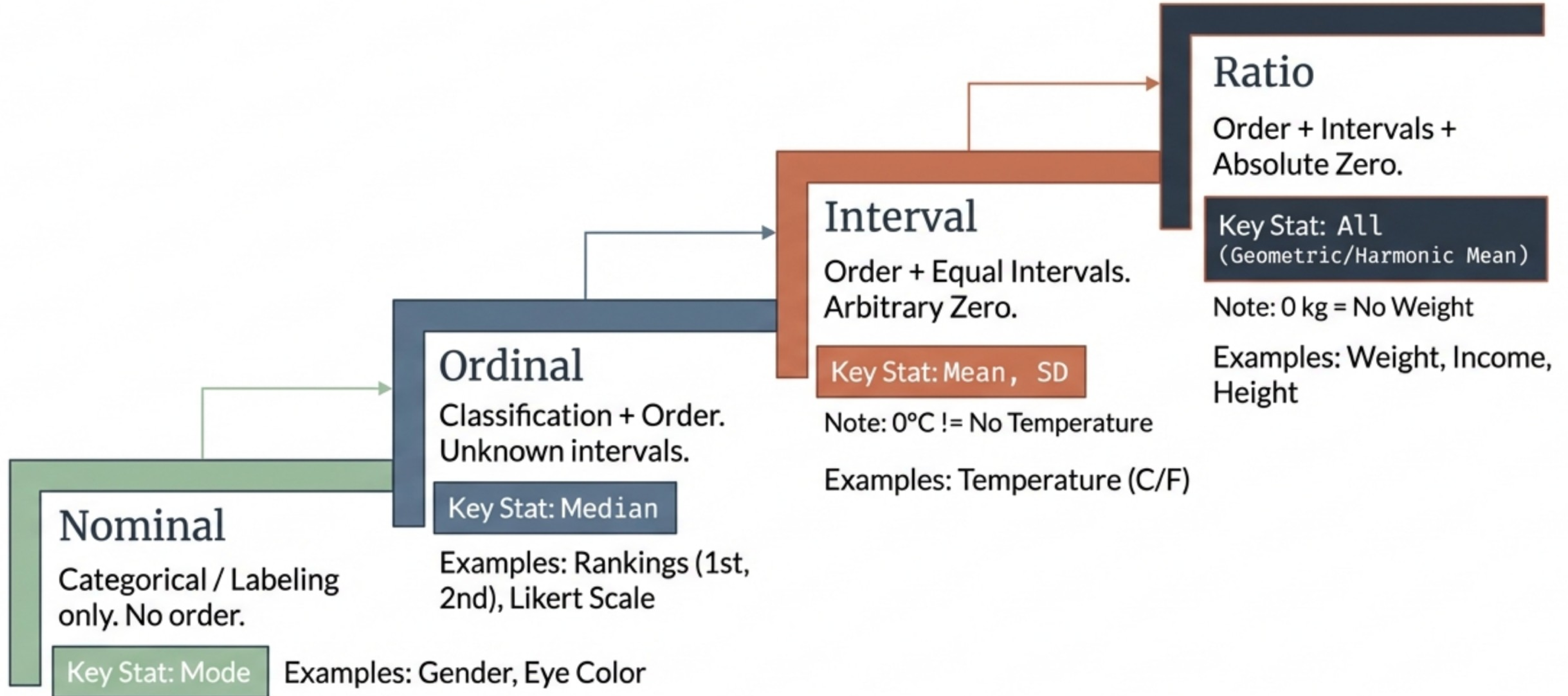
Validity Check



Sampling Logic: Probability vs. Non-Probability



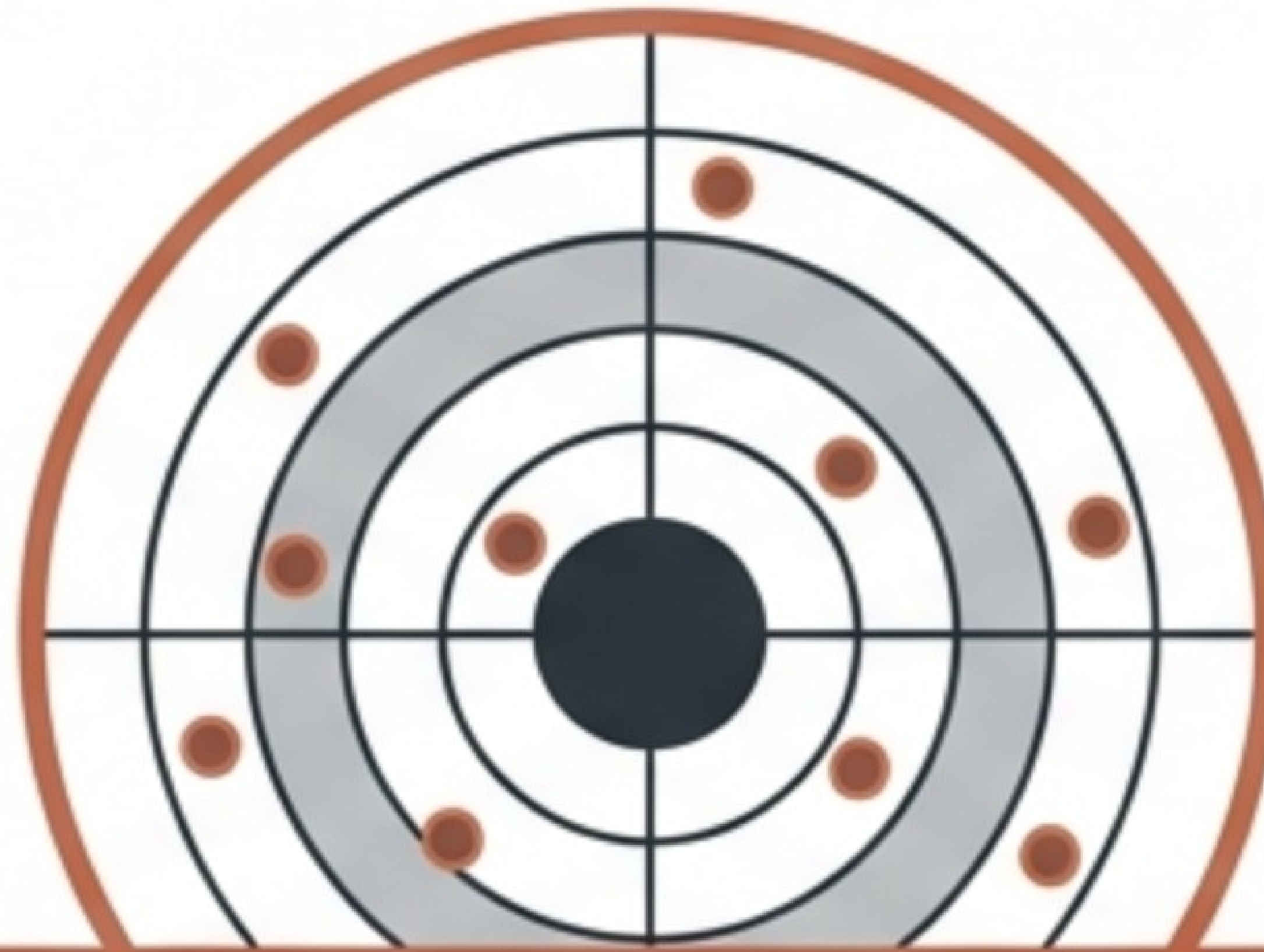
The Hierarchy of Measurement (NOIR Scale)



Precision in Measurement: Reliability & Validity



Target A
Reliable, Not Valid
(Consistent Error)



Target B
Neither Reliable nor Valid
(Random Error)



Target C
Valid & Reliable
(Accurate & Consistent)

Reliability (Consistency)

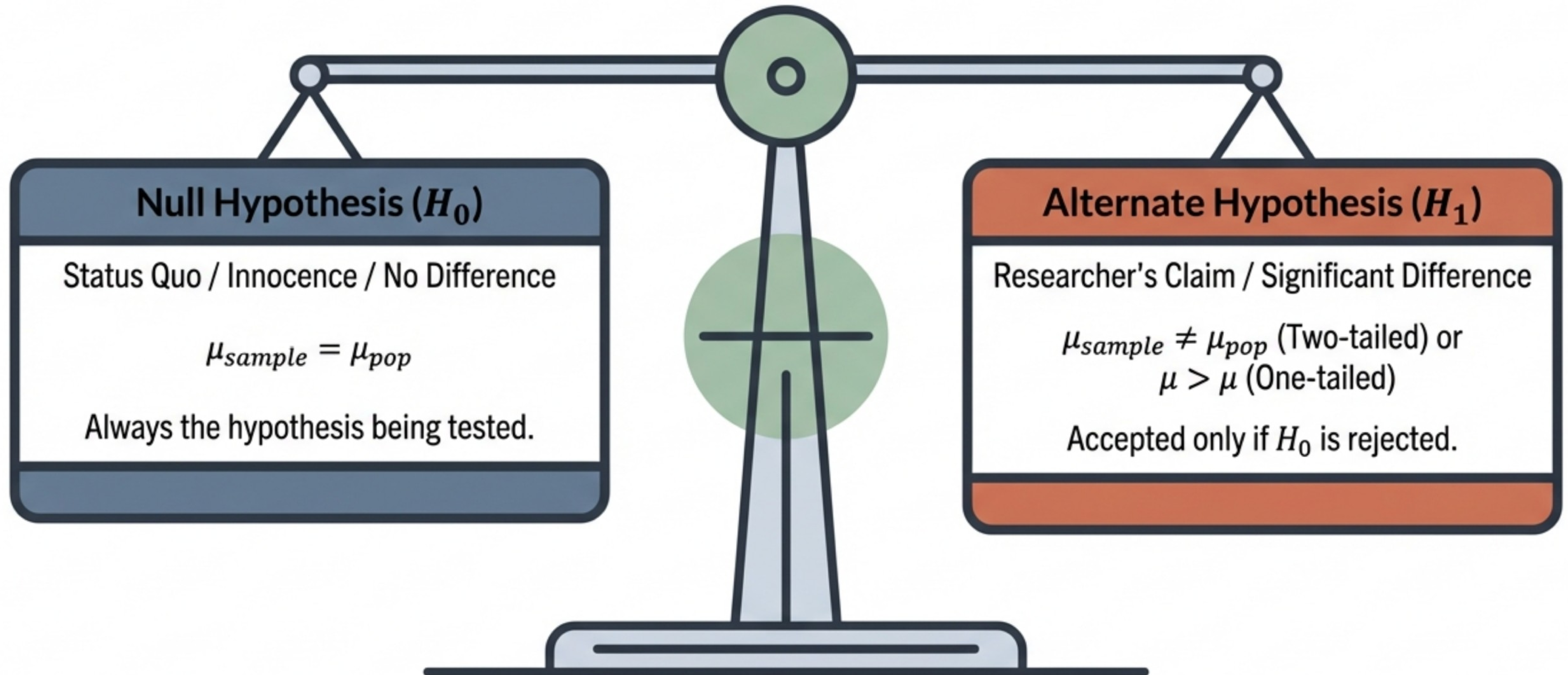
- Test-Retest (Stability over time)
- Inter-rater (Observer consistency)
- Internal Consistency: Split-Half & Cronbach's Alpha (>0.7 is good)

Validity (Accuracy)

- Content (Syllabus coverage)
- Construct (Theoretical trait - Convergent/Discriminant)
- Criterion (Predictive/Concurrent outcomes)

Axiom: A test can be reliable without being valid, but cannot be valid without being reliable

The Logic of Hypothesis Testing



Process: We gather statistical evidence to reject the Null (H_0) to support the Alternate (H_1).

Decision Errors & Statistical Power

	Reality: H_0 is TRUE	Reality: H_0 is FALSE
Decision: Reject H_0	Type I Error (α) False Positive. Convicting the innocent. Risk = Level of Significance.	Correct Decision Power of Test ($1 - \beta$).
Decision: Accept H_0	Correct Decision Confidence Level ($1 - \alpha$).	Type II Error (β) False Negative. Acquitting the guilty.

P-Value Logic:

- If $P < \alpha \rightarrow$ Reject H_0 (Significant)
- If $P > \alpha \rightarrow$ Accept H_0 (Not Significant)

Parametric Tests: Assumptions & Applications

Prerequisites	Comparison of Means	Analysis of Variance
● Normal Distribution ● Homogeneity of Variance ● Interval or Ratio Data ● Independence of observations	Z-Test Sample Size: Large ($n > 30$) Population SD (σ): Known T-Test (Student's t) Sample Size: Small ($n < 30$) Population SD: Unknown $t = \frac{\bar{x} - \mu}{s/\sqrt{n}}$	F-Test / ANOVA ● Compares Variance or Means of 3+ groups. ● One-Way ANOVA: Extension of T-test.

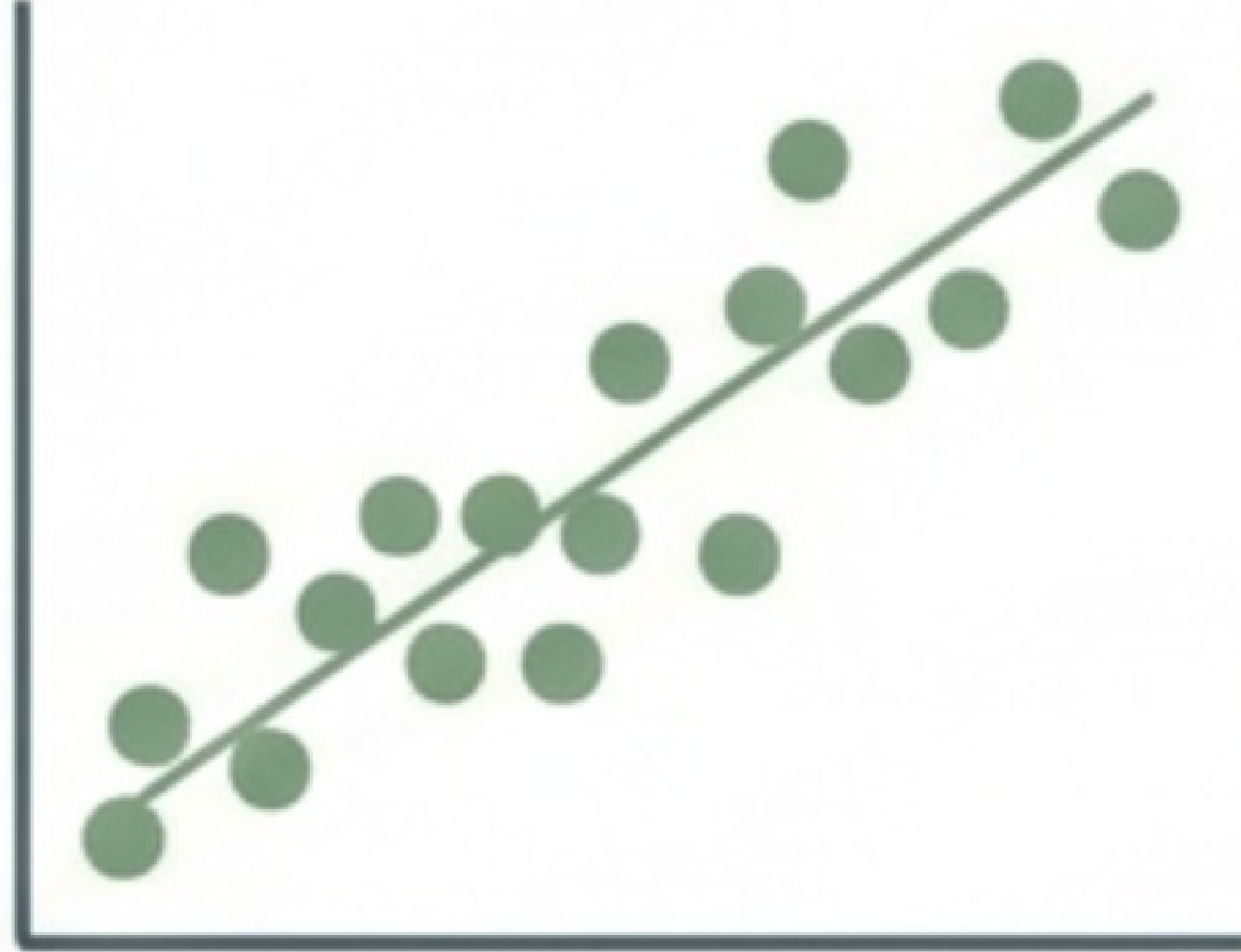
Non-Parametric Tests: Distribution-Free Analysis

Used when data is Nominal/Ordinal or assumptions of normality are violated.

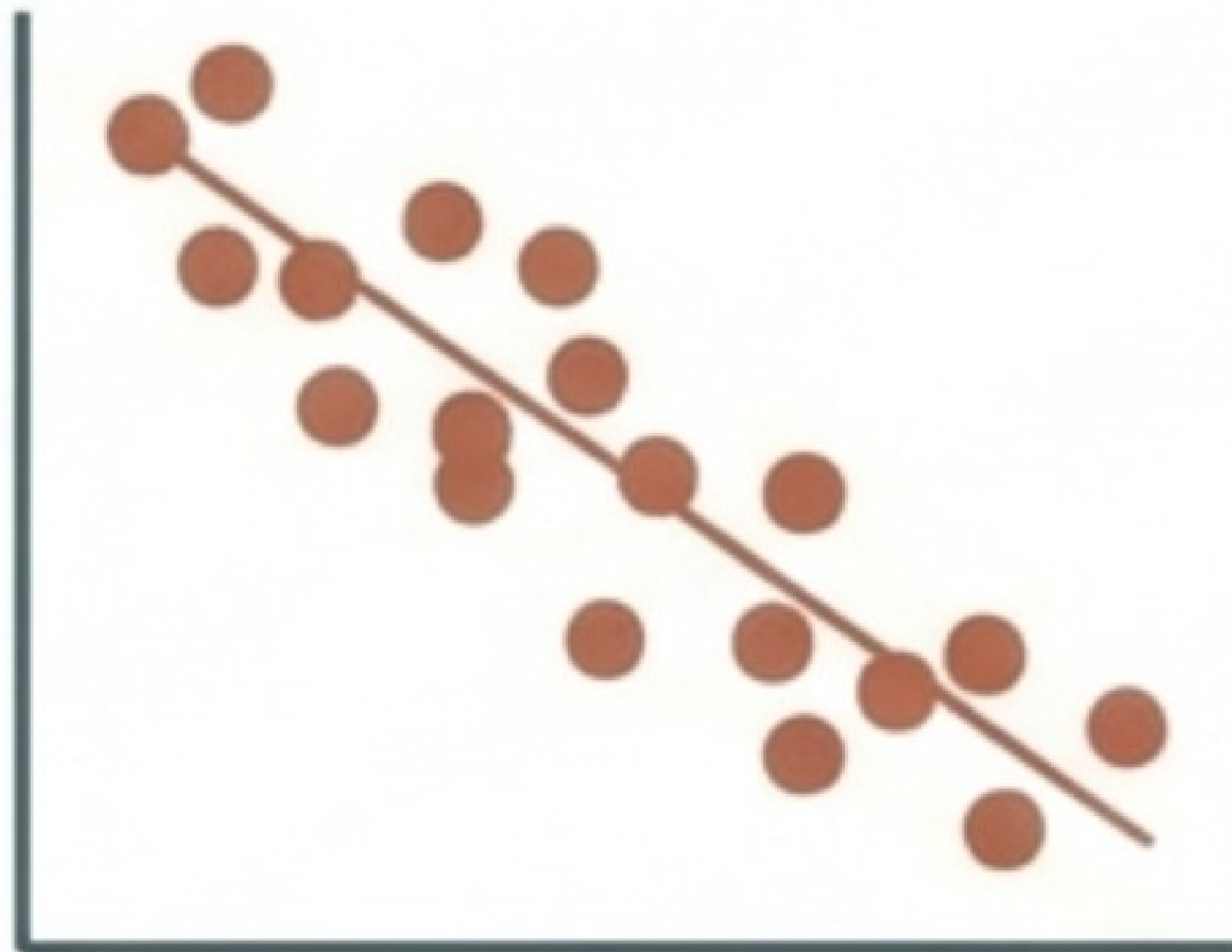
Parametric Equivalent / Purpose	Non-Parametric Test & Details
Categorical Data Analysis	Chi-Square (χ^2) Test ● Test of Independence or Goodness of Fit. ● Compares Observed vs. Expected Frequencies. ● Formula: $df = (r-1)(c-1)$
Alternative to: Independent T-test	Mann-Whitney U Test ● Use: Comparing two independent groups (ranks).
Alternative to: One-Way ANOVA	Kruskal-Wallis H Test ● Use: Comparing 3+ groups (ranks).
Alternative to: Paired T-test	Wilcoxon Signed-Rank Test
Alternative to: Pearson Correlation	Spearman's Rank Correlation ● (for ordinal data).

Correlation & Regression Analysis

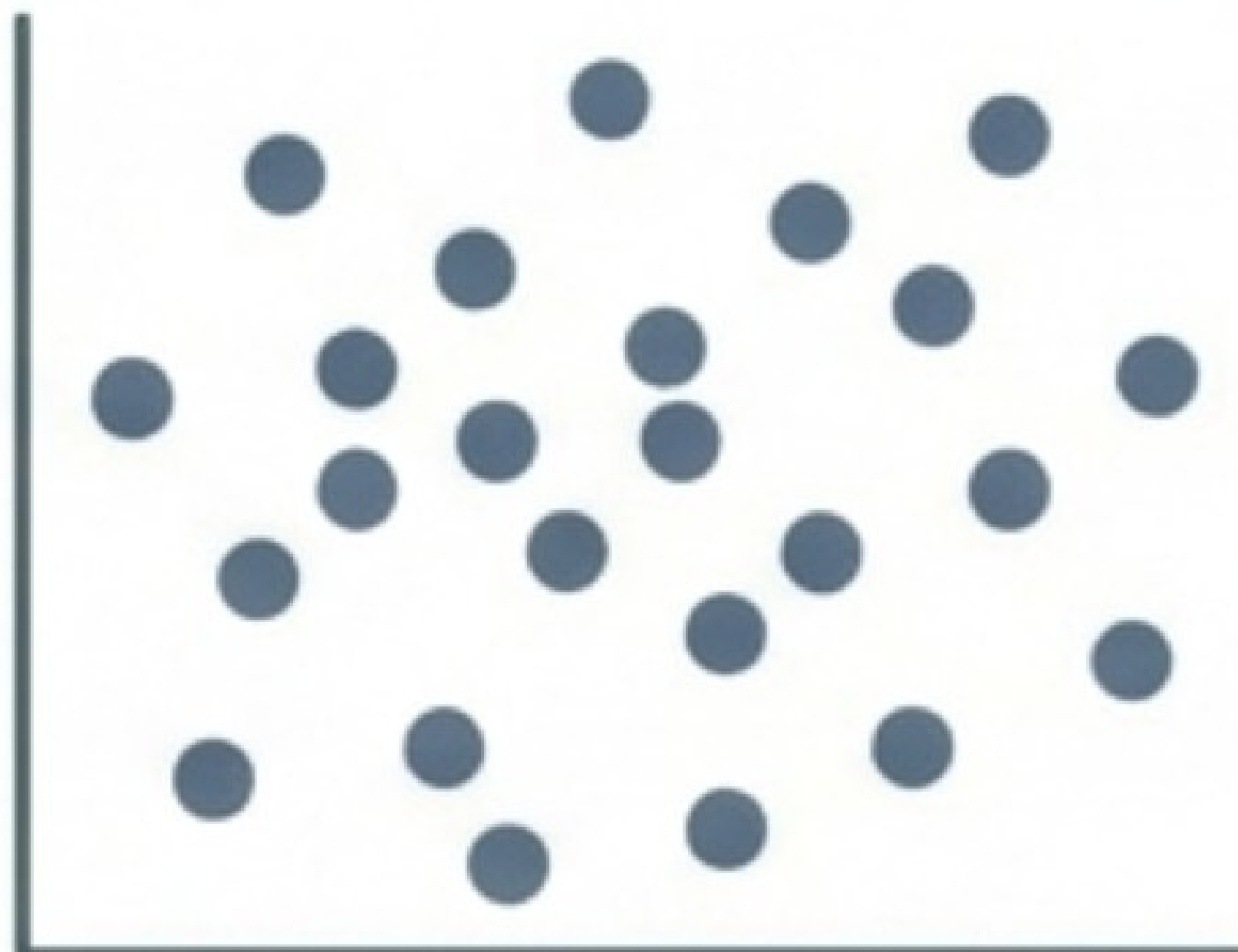
**Positive
Correlation**



**Negative
Correlation**



**Zero
Correlation**



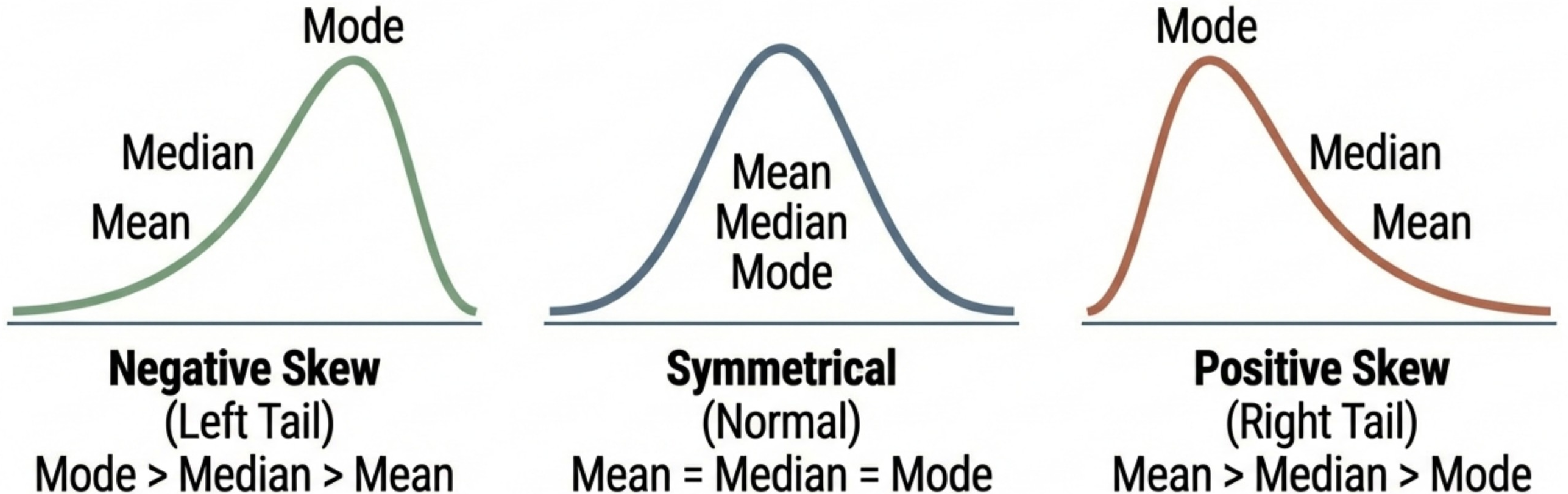
Correlation (r):

- Range: -1 to +1
- r^2 : Coefficient of Determination (Explained Variation)
- **Crucial Property:** Independent of Origin AND Scale (Units do not affect r).

Regression (b_{xy}, b_{yx}):

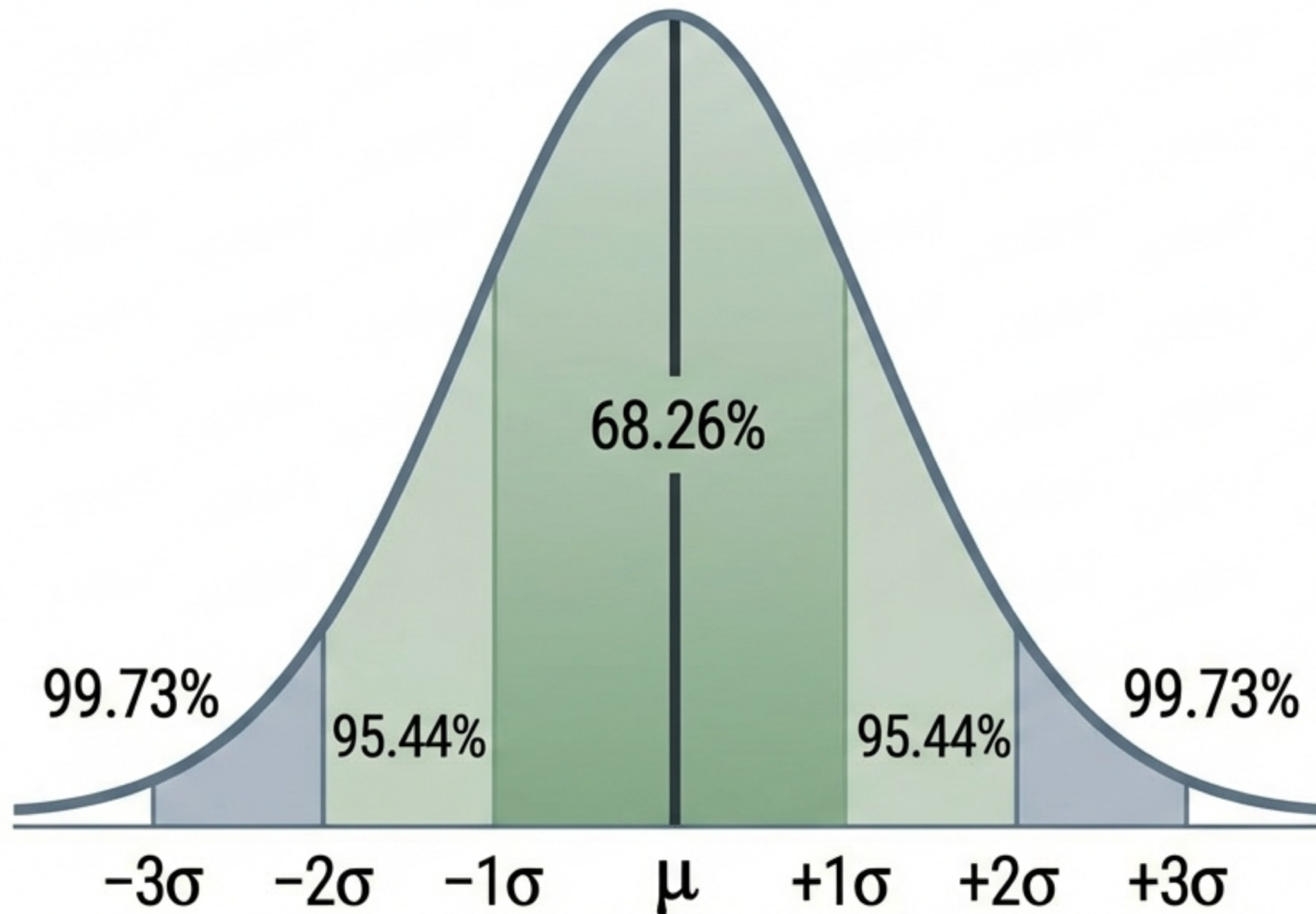
- Prediction equation: $Y = a + bX$
- **Formula:** $r = \sqrt{b_{xy} \cdot b_{yx}}$ (Geometric Mean of regression coefficients)
- **Crucial Property:** Independent of Origin, but **Dependent on Scale.**

Central Tendency & Skewness



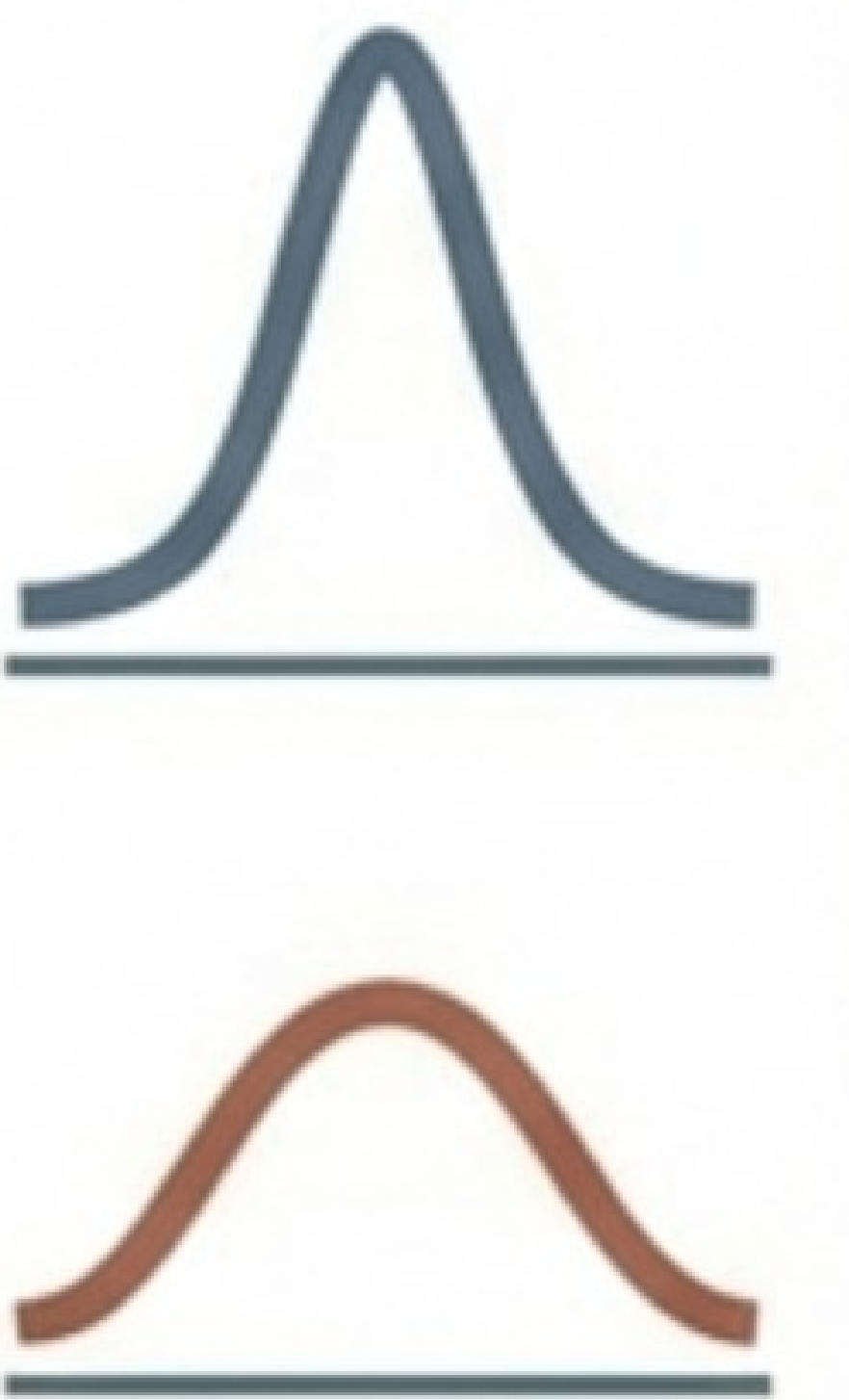
- **Empirical Formula:** $\text{Mode} = 3\text{Median} - 2\text{Mean}$
- **Dispersion Metric:** $\text{CV (Coefficient of Variation)} = (SD / \text{Mean}) \times 100$
(Lower CV = Higher Consistency).

The Normal Probability Distribution (NPC)



Key Properties

- Symmetrical, Asymptotic to baseline.
- **Mean = Median = Mode.**
- **Skewness = 0.**
- **Kurtosis = 3** (Mesokurtic).
- **Kurtosis Types:**
 - Leptokurtic** (>3 , peaked),
 - Platykurtic** (<3 , flat).



Discrete Probability Distributions

Binomial Distribution

- **Type:** Discrete
- **Use:** Bernoulli Trials (Success/Failure)
- **Parameters:** Finite n , fixed p



- Mean = np
- Variance = npq
- SD = $\sqrt{npq}$

Poisson Distribution

- **Type:** Discrete
- **Use:** Rare Events (e.g., defects per unit)
- **Parameters:** Infinite n , very small p



Golden Rule: Mean = Variance = m
(Standard Deviation = $\sqrt{m}$)

The Revision Checklist: Exam Strategy

- ☐ **Identify Data Type:** 'Nominal/Ordinal? → Non-Parametric.'
↳ Interval/Ratio? → Parametric.'
- ☐ **Check Sample Size:** ' $n < 30$? → T-test.' → ' $n > 30$? → Z-test.'
- ☒ **Hypothesis Logic:** 'Relationship? → Correlation.' → Prediction? → Regression.'
↳ Difference? → T/F/ANOVA.'
- ☐ **Error Check:** 'Type I (α) = Reject True Null.'
↳ Type II (β) = Accept False Null.'
- ☒ **Golden Rule:** 'Statistics is about the weight of evidence (P-value) against the Status Quo (Null).'

"Statistics is the grammar of science." – Karl Pearson