How do my distributions differ? Significance testing for the Overlapping Index using Permutation Test

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Abstract

Psychological research frequently relies on statistical tests targeting single distributional parameters, typically means, despite empirical data often differing in variance, skewness, or overall shape. We introduce the ζ-Overlapping test, a permutation-based inferential procedure built on the Overlapping Index, an effect size quantifying similarity between empirical distributions. The proposed approach evaluates global distributional differences without relying on parametric assumptions. Through simulations manipulating mean, variance, skewness, and sample size, we compare the ζ-Overlapping test with commonly used procedures (t, Welch, Wilcoxon–Mann–Whitney, Kolmogorov–Smirnov, and variance tests). Results show accurate Type I error control and substantially higher power than parameter-specific tests across a wide range of non-normal scenarios, with strong performance even from small sample sizes. An applied example using reaction-time data demonstrates how distributional overlap detects differences missed by mean-based analyses. Rather than replacing traditional tests, the method provides a theoretically aligned global assessment that encourages distribution-aware inference and integration of visualization and descriptive analysis into statistical workflows. The ζ-Overlapping framework supports ongoing methodological shifts in psychological science toward robust, assumption-light, and interpretable statistical reasoning.

Keywords: simulation, type I error, data visualization, reaction time, Nonparametric inference