

"The more power sought, the increased likelihood of finding false power", Tingwei Adeck 2023

"The search for a true positive is also the search for a false positive or Type I error", Tingwei Adeck 2023

Q: What does the Equality of Variance (EOV) test really seek to uncover?

Paired T-test

Preamble

It is important to be reminded in data analysis, that data is drawn from reality (experiments) and this fact should always provide the impetus to get data right.

For a paired tests, EOV seeks to uncover any experimental errors that can undermine the integrity of the analysis (after the fact) or experiment (before the fact). In a paired t-test, the determination of the presence of outliers (derived from boxplots or skewness/kurtosis of a histogram) within a group is a good indicator of the equality of variance assumption being put to a serious test. Unlike an independent test that possesses natural sources of experimental errors, a paired test often eliminates these unpaired test experimental errors but contains errors that are often unforeseen or experimenter-driven.¹

Treatment effects are uniform or very close to uniform on matched pairs across different treatments applied; simplistically, this means Hi, Mid, & Lo performers or

¹ In the old test vs new test example; what if the experimenter performed a one-sided substitution with an alien(s) or monkey(s). This will mean one side contained the original matched pair and the other side contained an altered matched pair. This example is part of the long version of this document.

subjects should be the same across different treatments. The uniformity of effects from disparate treatments signals that the similarity of distributions can be a way to circumvent the EOV test, especially with the paired test. The uniformity of treatment effects (given matched samples) in paired tests significantly reduces noise from treatment effects, so experimental errors are the main drivers of distortion in paired tests integrity.

Summary

EOV test in paired tests or analysis ensures minimization of experimental errors (unforeseen or experimenter-driven) that can distort the integrity of the analysis. It is safe to posit that the similarity of distributions in a t-test can circumvent the EOV test given the minimization of experimental errors and uniformity of treatment effects. The paired test is a more powerful test relative to the unpaired test since treatment effects can be well isolated given the utilization of similar groups in testing disparate treatments. The more powerful test is also highly prone to Type I errors.

Unpaired test(s) (Noisy test)

Preamble

For unpaired tests, EOV seeks to uncover treatment effects or experimental errors that can undermine the integrity of the analysis (after the fact) or experiment (before the fact). The absence of sample size constraints in unpaired tests is a strong factor that elicits the importance of separating the outlier(s) test from the EOV test. The presence of outliers is lot more dynamic and less intentional in

unpaired tests as outliers often occur from inherent factors linked to sampling populations (sampling errors).

Treatment effects are NOT uniform across groups given separate samples and so treatment effects become noise contributors (not on their own but by virtue of the differences in samples). The similarity in distributions here can be a coincidence and so a test for distribution similarities becomes an invalid option for circumventing the EOV test. The EOV test is an additional layer of verification to ensure that similar distributions were well sampled (ruling out sampling errors) and treatment-group interactions did not generate excessive noise. The message should be clear that sampling errors are the first sources of experimental errors in unpaired tests; a concern absent or negated in paired tests by matching pairs.

Summary

The similarity of distributions test is viable as a stand-alone assumption in paired tests but proves insufficient in unpaired tests. In unpaired tests, sampling errors (outliers) the absence of sample size constraints (affect distribution behavior), and the interaction of treatments with disparate groups are obvious reasons necessitating the need for the distribution assessments and the EOV test.

The EOV test ensures that experimental errors and treatment effects a priori do NOT distort experimental integrity, as an effect, disrupt data analysis.

Conclusion

EOV test in a paired test ensures that samples are valid candidates for comparisons and that experimental errors did not distort experimental integrity negating the need for analysis. The hypothesis is an EOV test can be circumvented with a similarity of distributions test.

EQUALITY OF VARIANCE (LAVENE'S TEST OR F-TEST)

EOV test for unpaired tests is an additional layer of verification to validate or invalidate the similarity of distributions test and further verify that treatment-group interactions did not generate excessive noise so as to perturb analysis of the data.

Unpaired Tests

