Annals of the Institute of Statistical Mathematics (2020) 72:997–1022
https://doi.org/10.1007/s10463-019-00717-3

Nonparametric MANOVA in meaningful effects

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Received: 20 April 2018 / Revised: 13 March 2019 / Published online: 6 April 2019

Abstract

Multivariate analysis of variance (MANOVA) is a powerful and versatile method to infer and quantify main and interaction effects in metric multivariate multi-factor data. It is, however, neither robust against change in units nor meaningful for ordinal data. Thus, we propose a novel nonparametric MANOVA. Contrary to existing rank-based procedures, we infer hypotheses formulated in terms of meaningful Mann–Whitney-type effects in lieu of distribution functions. The tests are based on a quadratic form in multivariate rank effect estimators, and critical values are obtained by bootstrap techniques. The newly developed procedures provide asymptotically exact and consistent inference for general models such as the nonparametric Behrens–Fisher problem and multivariate one-, two-, and higher-way crossed layouts. Computer simulations in small samples confirm the reliability of the developed method for ordinal and metric data with covariance heterogeneity. Finally, an analysis of a real data example illustrates the applicability and correct interpretation of the results.

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Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10463-019-00717-3) contains supplementary material, which is available to authorized users.

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Keywords Covariance heteroscedasticity · Multivariate data · Multivariate ordinal data · Multiple samples · Rank-based methods · Wild bootstrap