Estimating intraclass correlation and its confidence interval in linear mixed models

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Abstract

The methodology proposed in this study is motivated by an example from the medical field. Oncologists delineate organs for radiotherapy and it is essential that the measurements agree in these procedures. To assess the consistency of measurements among oncologists, on a random sample of subjects, the intraclass correlation (ICC) would yield a suitable estimate for studying the agreement.

In technical terms, the ICC is a ratio of sum of variances that are related to differences among measured subjects and the total variance. What variance is considered relevant depends on the design of agreement study; respectively, the number of variance components changes in the numerator and the denominator of the ICC. For statistical inference, it is important but challenging to determine the distribution of estimators of such ratios and to construct the confidence intervals. In most literature, the ICC has been studied for one-way and two-way analysis of variance only. Most proposed approximate methods are based on functions of the mean squares which are model-specific (e.g. two factorial) and lack generalization to higher order (e.g. three factorial) models.

The objective of this study is to extend the construction of confidence intervals for the linear mixed models, but in particular to our three-way mixed models for delineation of organs. The generalization will coincide with existing methods for two-way and one-way mixed effects models. To obtain an approximate upper and lower confidence limits, we approximate the ICC with a function of F-distributed variable and a Beta distribution. Our proposed methodology is supported by simulation studies.

Keywords

Linear mixed model, Confidence interval, Intraclass correlation, Small sample.

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