The Effective Sample Size and an Alternative Small Sample Degrees of Freedom Method

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Correlated data frequently arise in contexts such as, for example, repeated measures and meta-analysis. The amount of information in such data depends not only on the sample size, but also on the structure and strength of the correlations among observations from the same independent block. A general concept is discussed, the *effective sample size*, as a way of quantifying the amount of information in such data. It is defined as the sample size one would need in an independent sample to equal the amount of information in the actual correlated sample. This concept is widely applicable, for Gaussian data and beyond, and provides important insight. For example, it helps explaining why fixed-effects and random-effects inferences of meta-analytic data can be so radically divergent. Further, we show that in some cases the amount of information is bounded, even when the number of measures per independent block approaches infinity. We use the method to devise a new denominator degrees-of-freedom method for fixed-effects testing. It is compared to the classical Satterthwaite and Kenward-Roger methods for performance and, more importantly, to enhance insight. A key feature of the proposed degrees-of-freedom method is that it, unlike the others, can be used for non-Gaussian data too; it is exemplified for binary data. The method is scrutinized in a set of simulations and applied to three case studies: a meta-analysis in ovarian cancer, clustered dose-response data, and a longitudinal pre-clinical study.