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The GUM perspective on straight-line errors-in-variables regression

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For linear errors-in-variables regression, various methods are available to estimate the parameters, e.g. least-squares, maximum likelihood, method of moments and Bayesian methods. In addition, several approaches exist to assign probability distributions, and herewith uncertainties, to such estimators.

Following the standard approach in metrology (the Guide to the expression of uncertainty in measurement GUM), the slope and intercept in straight-line regression tasks can be estimated and their uncertainty evaluated by defining a measurement model. Minimizing the weighted total least-squares (WTLS) functional appropriately defines such a model when both regression input quantities (X and Y) are uncertain.

This contribution compares the uncertainty of the straight line in WTLS methods between two methods described in the GUM suite of documents, i.e. when evaluated by propagating distributions via the Monte Carlo method and by the law of propagation of uncertainty (LPU). The latter is in turn often approximated because the non-linear measurement model does not have closed form. We reason that the uncertainty recommended in the dedicated technical specification ISO/TS 28037:2010 does not fully implement the LPU (as intended) and can understate the uncertainty. A systematic simulation study quantifies this understatement and the circumstances where it becomes relevant. In contrast, the LPU uncertainty may often be appropriate. As a result, it is planned to revise ISO/TS 28037:2010.

Keywords

Errors-in-variables; Weighted total least-squares; Law of propagation of uncertainty

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