

Efficiency of profile likelihood in semi-parametric models

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Abstract Profile likelihood is a popular method of estimation in the presence of an infinite-dimensional nuisance parameter, as the method reduces the infinite-dimensional estimation problem to a finite-dimensional one. In this paper we investigate the efficiency of a semi-parametric maximum likelihood estimator based on the profile likelihood. By introducing a new parametrization, we improve on the seminal work of Murphy and van der Vaart (*J Am Stat Assoc*, 95: 449–485, 2000): our improvement establishes the efficiency of the estimator through the direct quadratic expansion of the profile likelihood, which requires fewer assumptions. To illustrate the method an application to two-phase outcome-dependent sampling design is given.

Keywords Semi-parametric model · Profile likelihood · Two-phase outcome-dependent sampling · Efficiency · M -estimator · Maximum likelihood estimator · Efficient score · Efficient information bound