Valid Post-Selection and Post-Regularization Inference: An Elementary, General Approach

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Here we present an expository, general analysis of valid post-selection or post-regularization inference about a low-dimensional target parameter in the presence of a very high-dimensional nuisance parameter which is estimated using selection or regularization methods. Our analysis provides a set of high-level conditions under which inference for the low-dimensional parameter based on testing or point estimation methods will be regular despite selection or regularization biases occurring in estimation of the high-dimensional nuisance parameter. The results may be applied to establish uniform validity of post-selection or post-regularization inference procedures for low-dimensional target parameters over large classes of models. The high-level conditions allow one to clearly see the types of structure needed for achieving valid post- regularization inference and encompass many existing results. A key element of the structure we employ and discuss in detail is the use of orthogonal or "immunized" estimating equations that are locally insensitive to small mistakes in estimation of the high-dimensional nuisance parameter. As an illustration, we use the high-level conditions to provide readily verifiable sufficient conditions for a class of affine-quadratic models that include the usual linear model and linear instrumental variables model as special cases. As a further application and illustration, we use these results to provide an analysis of post-selection inference in a linear instrumental variables model with many regressors and many instruments. We conclude with a review of other developments in post-selection inference and note that many of the developments can be viewed as special cases of the general encompassing framework of orthogonal estimating equations provided in this paper.