



# On the degrees of freedom of a smoothing parameter

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The concept of degrees of freedom is well established in the statistical community. It is used for testing, model selection and as a measure of leverage.

This talk is concerned with calculating the degrees of freedom for semiparametric regression models while accounting for the uncertainty that is induced by estimating the smoothing parameters. This leads to a natural definition of the degrees of freedom of a smoothing parameter which, however, heavily depends on the way the smoothing parameters are selected. Different methods have emerged for this task with the two most popular approaches being selection via generalized cross-validation (GCV) and marginal or restricted marginal likelihood (REML). We introduce the degrees of freedom of the smoothing parameters for quadratic penalties and smoothing parameter selection methods based on the optimization of any arbitrary differentiable criterion, in particular GCV and REML. Computational aspects of deriving the degrees of freedom of the smoothing parameter are considered. Furthermore, the degrees of freedom of a smoothing parameter have interesting geometrical properties that will be explored.

The practical use and the need for considering the degrees of freedom of the smoothing parameters for model selection in a semiparametric model is shown in an application to forestry data and a simulation study.