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Title: Constrained Penalized Splines

Abstract: Polynomial regression splines are flexible and parsimonious nonparametric function estimators that are computed as projections onto linear subspaces, and hence share many of the nice theoretical properties of the ordinary least-squares regression estimator. However, they are sensitive to the placement and number of knots. Two versions of the regression spline estimator are more robust: the penalized spline and the shape-constrained spline. These ideas are combined to give a shape-constrained version of the penalized spline. The penalty parameter may be chosen with generalized cross-validation, which also provides a method for determining if the shape restrictions hold. The constrained penalized spline has the same convergence rate as the unconstrained version if the shape restrictions hold. Small-sample properties of the estimators are demonstrated through simulations, and extensions to the partial linear model and the generalized regression model are straight-forward.