Spline models for observational data

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This book serves well as an introduction into the more theoretical aspects of the use of spline models. It develops a theory and practice for the estimation of functions from noisy data on functionals. The simplest example is the estimation of a smooth curve, given noisy observations on a finite number of its values. The estimate is a polynomial smoothing spline. By placing this smoothing problem in the setting of reproducing kernel Hilbert spaces, a theory is developed which includes univariate smoothing splines, thin plate splines in d dimensions, splines on the sphere, additive splines, and interaction splines in a single framework. A straightforward generalization allows the theory to encompass the very important area of (Tikhonov) regularization methods for ill-posed inverse problems.
Convergence properties, data based smoothing parameter selection, confidence intervals, and numerical methods are established which are appropriate to a wide variety of problems which fall within this framework. Methods for including side conditions and other prior information in solving ill-posed inverse problems are included. Data which involves samples of random variables with Gaussian, Poisson, binomial, and other distributions are treated in a unified optimization context. Experimental design questions, i.e., which functionals should be observed, are studied in a general context. Extensions to distributed parameter system identification problems are made by considering implicitly defined functionals.