

SPRINGER BRIEFS IN COMPUTER SCIENCE

Howard L. Weinert

# Fast Compact Algorithms and Software for Spline Smoothing



Springer

# Fast Compact Algorithms And Software For Spline Smoothing Springerbriefs In Computer Science

**John Winslow Lewis**



## **Fast Compact Algorithms And Software For Spline Smoothing Springerbriefs In Computer Science:**

**Fast Compact Algorithms and Software for Spline Smoothing** Howard L. Weinert, 2012-10-12 Fast Compact Algorithms and Software for Spline Smoothing investigates algorithmic alternatives for computing cubic smoothing splines when the amount of smoothing is determined automatically by minimizing the generalized cross validation score These algorithms are based on Cholesky factorization QR factorization or the fast Fourier transform All algorithms are implemented in MATLAB and are compared based on speed memory use and accuracy An overall best algorithm is identified which allows very large data sets to be processed quickly on a personal computer      One Dimensional Spline Interpolation Algorithms Helmuth Späth, 1995-05-02 Together with its companion volume this book presents a practical introduction to computing spline functions the fundamental tools for fitting curves and surfaces in computer aided design CAD and computer graphics

**A New Algorithm for Spline Smoothing Based on Smoothing a Stochastic Process** Robert Kohn, Craig F. Ansley, 1985      **Curve and Surface Fitting with Splines** Paul Dierckx, 1995 Describes the algorithms and mathematical fundamentals of a widely used FORTRAN package for curve and surface fitting with splines      **A Basic Program for Smoothing by Quadratic Splines** Ned Anderson, Kungl. Tekniska högskolan. Department of Information Processing and Computer Science, 1975      **Two Dimensional Spline Interpolation Algorithms** Helmuth Späth, 1993-05-31 These volumes present a practical introduction to computing spline functions the fundamental tools for fitting curves and surfaces in computer aided design CAD and computer graphics      *Fitting Splines to a Parametric Function* Alvin Penner, 2019-02-23 This Brief investigates the intersections that occur between three different areas of study that normally would not touch each other ODF spline theory and topology The Least Squares Orthogonal Distance Fitting ODF method has become the standard technique used to develop mathematical models of the physical shapes of objects due to the fact that it produces a fitted result that is invariant with respect to the size and orientation of the object It is normally used to produce a single optimum fit to a specific object this work focuses instead on the issue of whether the fit responds continuously as the shape of the object changes The theory of splines develops user friendly ways of manipulating six different splines to fit the shape of a simple family of epitrochoid curves two types of Bzier curve two uniform B splines and two Beta splines This work will focus on issues that arise when mathematically optimizing the fit There are typically multiple solutions to the ODF method and the number of solutions can often change as the object changes shape so two topological questions immediately arise are there rules that can be applied concerning the relative number of local minima and saddle points and are there different mechanisms available by which solutions can either merge and disappear or cross over each other and interchange roles The author proposes some simple rules which can be used to determine if a given set of solutions is internally consistent in the sense that it has the appropriate number of each type of solution      An Algorithm for Surface Smoothing with Rational Splines James R. Schiess, 1987      *Fast Algorithms for Smoothing Data Over a Disc Or a Sphere Using Tensor Product*

*Splines* P. Dierckx, 1985      *Approximation and Modeling with B-Splines* Klaus Hollig, Jorg Horner, 2013-11-14 B splines are fundamental to approximation and data fitting geometric modeling automated manufacturing computer graphics and numerical simulation With an emphasis on key results and methods that are most widely used in practice this textbook provides a unified introduction to the basic components of B spline theory approximation methods mathematics modeling techniques engineering and geometric algorithms computer science A supplemental Web site will provide a collection of problems some with solutions slides for use in lectures and programs with demos      **A Smoothing Algorithm Using Cubic Spline Functions** Robert Lee Smith, Joseph M. Price, Lona M. Howser, 1974      *Interpolating Cubic Splines* Gary D. Knott, 1999 The study of spline functions is an outgrowth of basic mathematical concepts arising from calculus analysis and numerical analysis Spline modelling affects a number of fields statistics computer graphics CAD programming and other areas of applied mathematics      **Spline Regression** John Winslow Lewis, 1978 Curve fitting has been an important problem in data analysis and curve design for many years Spline regression is a relatively new mathematical curve fitting method which has proved to be useful for moderately accurate 2 to 5 decimal digit approximations to data which are difficult to approximate by analytic means The qualitative behavior of least squares spline approximations differs significantly from that of most classical approximation schemes in that least squares splines are highly local While the value of a polynomial or any other analytic function at a point can be determined from its value and derivatives at any arbitrarily distant point the value of the least squares spline at any point is almost completely determined by neighboring data In this dissertation a detailed analysis of algorithms for computing and evaluating least squares spline approximations to data is presented The algorithms are given explicitly in an ALGOL like language and operation counts are presented Of particular interest are a fast incremental algorithm for evaluating splines and a limited storage algorithm for computing piecewise polynomial representations of splines      **An Algorithm for Computing Constrained Smoothing Spline Functions** Tommy Elfving, Lars-Erik Andersson, 1986      *Computing Smoothing Spline Models* Chong Gu, 1989      *Topics in Bivariate Spline Smoothing* Luo Xiao, 2012 Penalized spline methods have been popular since the work of Eilers and Marx 1996 Recent years saw extensive theoretical studies and a wide range of applications of penalized splines In this dissertation we consider penalized splines for smoothing two dimensional data In Chapter 2 we propose a new spline smoother the sandwich smoother for smoothing data on a rectangular grid Univariate P spline smoothers are applied simultaneously along both coordinates The sandwich smoother has a tensor product structure that simplifies an asymptotic analysis and it can be fast computed We derive a local central limit theorem for the sandwich smoother with simple expressions for the asymptotic bias and variance by showing that the sandwich smoother is asymptotically equivalent to a bivariate kernel regression estimator with a product kernel As far as we are aware this is the first central limit theorem for a bivariate spline estimator of any type Our simulation study shows that the sandwich smoother is orders of magnitude faster to compute than other bivariate spline smoothers even

when the latter are computed using a fast GLAM Generalized Linear Array Model algorithm and comparable to them in terms of mean squared integrated errors One important application of the sandwich smoother is to estimate covariance functions in functional data analysis In this application our numerical results show that the sandwich smoother is orders of magnitude faster than local linear regression In Chapter 3 based on the sandwich smoother we propose a fast covariance function estimation method FACE for smoothing high dimensional functional data We show that our method overcomes the computational difficulty of common bivariate smoothers for smoothing high dimensional covariance operators and in particular we derive a fast algorithm for selecting the smoothing parameter We also show that through FACE we can simultaneously obtain the smoothed covariance operator and its associated eigenfunctions For functional principal component analysis we derive a fast method for calculating the principal scores A simulation study is done to illustrate the computational speed of FACE Although not a focus of this dissertation we present in Appendix A a theoretical study of the local asymptotics of P splines for the univariate case In this work we derived the local asymptotic distribution of P splines at both an interior point and near the boundary Some of the results in the work are used in studying the sandwich smoother

**A New Algorithm for Spline Smoothing and Interpolation Based on Smoothing a Stochastic Process** Robert Kohn, Craig F. Ansley, 1984      **A Fast Algorithm for Smoothing Data on a Rectangular Grid While Using Spline Functions** P. Dierckx, 1980      Generalized Spline Models Chong Gu, 1989      *Spline Smoothing by Generalized Cross-validation* P. H. Merz, Chevron Research Company, 1982

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