

L^2 -MULTIVARIATE APPROXIMATION THEORY*

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1. Introduction. This paper is concerned with multivariate analogues of many standard results in the L^2 -approximation theory of real-valued functions of a real variable, cf. [2], [3], [7], [11] and [15]. In this paper, whenever we speak of a function, we shall always mean a real-valued function. Theorems 2.1 and 2.2 of § 2 enable us to deduce results about multivariate approximation in rectangular parallelepipeds from corresponding single variable results. In § 3 and § 4, we state and prove asymptotic bounds for the distance, in L^2 and various Sobolev type spaces, of a given smooth multivariate function from various finite-dimensional subspaces, i.e., if B is a real Banach space, $f \in B$, and C is a chosen set of finite-dimensional subspaces, S , of B , then we give upper bounds for the quantities $E(f, S, B) \equiv \inf_{y \in S} \|f - y\|_B$ for all $S \in C$. Subspaces consisting of multivariate trigonometric polynomials, multivariate algebraic polynomials, or multivariate L -splines, are studied in detail.

In § 5, we apply the results of § 3 and § 4 to the study of “ h -asymptotically optimal approximation schemes” in Sobolev spaces. These schemes include the Ritz method for approximating the solution of the Neumann problem for the Poisson equation for sufficiently smooth domains in R^N , cf. [9].

We end this section by recalling some multivariate notation which will be used throughout this paper, cf. [18]. For any $x \equiv (x_1, \dots, x_N) \in R^N$, $|x| \equiv (x_1^2 + \dots + x_N^2)^{1/2}$. If $\alpha \equiv (\alpha_1, \dots, \alpha_N)$ is an N -tuple with nonnegative integer components, then

$$D^\alpha \equiv D_1^{\alpha_1} \cdots D_N^{\alpha_N} \equiv \frac{\partial^{\alpha_1}}{\partial x_1^{\alpha_1}} \cdots \frac{\partial^{\alpha_N}}{\partial x_N^{\alpha_N}}$$

and $|\alpha| \equiv \alpha_1 + \dots + \alpha_N$. If $\Omega \subset R^N$ is a bounded measurable set, m a nonnegative integer, and $1 < p < \infty$, $W^{m,p}(\Omega)$ denotes the space of $L^p(\Omega)$ functions which have weak derivatives of order up to m in $L^p(\Omega)$,

$$\|f\|_{W^{m,p}(\Omega)} \equiv \left(\sum_{|\alpha| \leq m} \|D^\alpha f\|_{L^p(\Omega)}^p \right)^{1/p}$$

for all $f \in W^{m,p}(\Omega)$, and $W_0^{m,p}(\Omega)$ denotes the closure of $C_0^\infty(\Omega)$ with respect to the Sobolev norm $\|\cdot\|_{W^{m,p}(\Omega)}$.

If $-\infty < a < b < \infty$ and t is any positive integer, $K^t(a, b)$ is the set of all functions $f \in C^{t-1}[a, b]$ such that $D^{t-1}f$ is absolutely continuous and $D^t f \in L^2(a, b)$. If $-\infty < a_i < b_i < \infty$ for $1 \leq i \leq N$, $H \equiv \prod_{i=1}^N [a_i, b_i]$, and t is any positive integer, $K^t(H)$ is the set of all functions $f \in C^{t-1}(H)$, such that $D_i^{t-1}f$ is absolutely continuous for $1 \leq i \leq N$ and $D_i^t f \in L^2(H)$ for $1 \leq i \leq N$, $K_n^t(H)$

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Multivariate Approximation Theory 2

CHUI,SCHEMP,ZELLER



Multivariate Approximation Theory 2:

Multivariate Approximation Theory II : Proceedings of the Conference Held at the Mathematical Research Institute at Oberwolfach Walter Schempp,1982 **Multivariate Approximation Theory II** Schempp,Zeller,2012-12-06 The Third International Symposium on Multivariate Approximation Theory was held at the Oberwolfach Mathematical Research Institute Black Forest February 8 12 1982 The preceding conferences on this topic were held in 1976 and 1979 The conference brought together 50 mathematicians from 14 countries These Proceedings form a record of most of the papers presented at the Symposium The topics treated cover different problems on multivariate approximation theory such as new results concerning approximation by polynomials in Sobolev spaces biorthogonal systems and orthogonal series of functions in several variables multivariate spline functions group theoretic and functional analytic methods positive linear operators error estimates for approximation procedures and cubature formulae Boolean methods in multivariate interpolation and the numerical application of summation procedures Special emphasis was posed on the application of multivariate approximation in various fields of science One mathematician was sorely missed at the Symposium Professor Arthur Sard who had actively taken part in the earlier conferences passed away in August of 1980 Since he was a friend of many of the participants the editors wish to dedicate these Proceedings to the memory of this distinguished mathematician A brief appreciation of his life and mathematical work appears as well Constructive Theory of Functions of Several Variables Edited by W. Schempp and Karl Zeller Lecture Notes in Mathematics Vol. 111 *Multivariate Approximation Theory IV* CHUI,SCHEMP,ZELLER,2013-03-08 Multivariate Approximation Theory forms a rapidly evolving field in Applied Mathematics The reason for its particular current interest lies in its impact on Computer Aided Geometric Design CAGD Image Processing Pattern Recognition and Multidimensional Signal Processing Multivariate Bernstein polynomials and box splines for example play an important role in CAGD Conversely the highly important filter bank design problem of signal processing for instance gives rise to a new family of multivariate approximating functions the Gabor wavelets with interesting technological and biological applications The conferences on Multivariate Approximation Theory held at the Mathematical Research Institute at Oberwolfach Black Forest in 1976 1979 1982 1985 and 1989 reflect the progress made in this area and related fields The present volume which is a continuation of the preceding volumes Constructive Theory of Functions of Several Variables Lecture Notes in Mathematics 571 1977 Multivariate Approximation Theory ISNM 51 1979 Multivariate Approximation Theory II ISNM 61 1982 Multivariate Approximation Theory III ISNM 75 1985 is based on the conference held on February 12 18 1989 It includes most of the lectures presented at the Oberwolfach meeting and reveals the wide spectrum of activities in the field of multivariate approximation The organizers are grateful to the Director of the Oberwolfach Mathematical Research Institute Professor Dr M. Barner and his staff for providing the facilities and to Dr G. Baszenski Professor Dr F. J. Delvos Dr H.

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Multivariate Approximation Theory was held at the Oberwolfach Mathematical Research Institute Black Forest W Germany during the week of January 20-26 1985 The preceding conferences on this topic were held in 1976 1979 and 1982 We were pleased to have more than 50 mathematicians from 13 countries in attendance The program included 40 lectures These Proceedings form a record of most of the papers presented at the Symposium The topics treated cover different problems on multivariate approximation such as polynomial approximation on simplices multivariate splines box splines dimension of spline spaces blending methods multivariate Hermite interpolation data smoothing and surface representation and multivariate summation methods We would like to thank the director of the Oberwolfach Mathematical Research Institute Prof Dr M Barner and his staff for providing the facilities Of the people who gave their time to help make this conference a success we would like to mention in particular Prof Dr F J Delves Siegen Dr G Baszenski College Station Texas and Dipl Math H Nienhaus Siegen Finally our thanks are due to Carl Einsele of Birkhauser Publishers for his valuable cooperation

Topics in Multivariate Approximation C. K. Chui, L. L. Schumaker, F. I. Utreras, 2014-05-10 Topics in Multivariate Approximation contains the proceedings of an international workshop on multivariate approximation held at the University of Chile in Santiago Chile on December 15-19 1986 Leading researchers in the field discussed several problem areas related to multivariate approximation and tackled topics ranging from multivariate splines and fitting of scattered data to tensor approximation methods and multivariate polynomial approximation Numerical grid generation and finite element methods were also explored along with constrained interpolation and smoothing Comprised of 22 chapters this book first describes the application of Boolean methods of approximation in combination with the theory of right invertible operators to bivariate Fourier expansions The reader is then introduced to ill posed problems in multivariate approximation interpolation of scattered data by radial functions and shape preserving surface interpolation Subsequent chapters focus on approximation by harmonic functions numerical generation of nested series of general triangular grids triangulation methods and inequalities arising from best local approximations in rectangles A bibliography of multivariate approximation concludes the book This monograph will be of interest to mathematicians

Multivariate Approximation Theory E. W. Cheney, 1986-01-01 The approximation of functions of several variables continues to be a difficult problem in scientific computing because many of the algorithms required for such problems have yet to be written This monograph is written for a broad audience of computational mathematicians and statisticians concerned with the development of algorithms or the derivation of approximations from linear projections of which the interpolating operators are an important example As an aid to both researchers and students a bibliography of more than 200 titles is included

Multivariate Approximation Theory Walter Schempp, Karl Zeller, 1980-01-01 *Multivariate Approximation Theory III* Walter Schempp, 1985-09-01

Multivariate Approximation : From Cagd To Wavelets - Proceedings Of The International Workshop Kurt Jetter, F I Utreras, 1993-11-30 Contents Fast Algorithms for Simultaneous Polynomial Approximation G Baszenski M Tasche

Spline of Smoothing for Correlated Errors in Dimension Two M Bozzini L Lenarduzzi New Developments in the Theory of Radial Basis Function Interpolation M D Buhmann Realization of Neural Networks with One Hidden Layer C K Chui X Li A General Method for Constrained Curves with Boundary Conditions P Costantini Sign Regular and Totally Positive Matrices An Algorithmic Approach M Gasca J M Peña Some Results on Blossoming and Multivariate B Splines R Gormaz P J Laurent Riesz Bounds in Scattered Data Interpolation and L₂ Approximation K Jetter On Multivariate Hermite Polynomial Interpolation A Le Maître Quantitative Approximation Results for Sigma Pi Type Neural Network Operators B Lenze Local Interpolation Schemes From Curves to Surfaces D Levin Some Results on Approximation by Smoothing Spline Splines M C L de Silanes Readership Applied mathematicians [Acta Numerica 1993: Volume 2](#) Arieh Iserles, 1993-04-30 Continuing the tradition established with the 1992 volume this 1993 s Acta Numerica presents six invited papers on a broad range of topics from numerical analysis Papers treat each topic at a level intelligible by any numerical analyst from graduate student to professional *Handbook of Splines* Gheorghe Micula, Sanda Micula, 2012-12-06 The purpose of this book is to give a comprehensive introduction to the theory of spline functions together with some applications to various fields emphasizing the significance of the relationship between the general theory and its applications At the same time the goal of the book is also to provide new material on spline function theory as well as a fresh look at old results being written for people interested in research as well as for those who are interested in applications The theory of spline functions and their applications is a relatively recent field of applied mathematics In the last 50 years spline function theory has undergone a wonderful development with many new directions appearing during this time This book has its origins in the wish to adequately describe this development from the notion of spline introduced by I J Schoenberg 1901 1990 in 1946 to the newest recent theories of spline wavelets or spline fractals Isolated facts about the functions now called splines can be found in the papers of L Euler A Lebesgue G Birkhoff J **Multivariate Approximation Theory**, 1979 *Multivariate Approximation Theory IV* CHUI, SCHEMP, ZELLER, 2014-03-12 Multivariate Approximation Theory forms a rapidly evolving field in Applied Mathematics The reason for its particular current interest lies in its impact on Computer Aided Geometric Design CAGD Image Processing Pattern Recognition and Multidimensional Signal Processing Multivariate Bernstein polynomials and box splines for example play an important role in CAGD Conversely the highly important filter bank design problem of signal processing for instance gives rise to a new family of multivariate approximating functions the Gabor wavelets with interesting technological and biological applications The conferences on Multivariate Approximation Theory held at the Mathematical Research Institute at Oberwolfach Black Forest in 1976 1979 1982 1985 and 1989 reflect the progress made in this area and related fields The present volume which is a continuation of the preceding volumes Constructive Theory of Functions of Several Variables Lecture Notes in Mathematics 571 1977 Multivariate Approximation Theory ISNM 51 1979 Multivariate Approximation Theory II ISNM 61 1982 Multivariate Approximation Theory III ISNM 75

1985 is based on the conference held on February 12-18 1989. It includes most of the lectures presented at the Oberwolfach meeting and reveals the wide spectrum of activities in the field of multivariate approximation. The organizers are grateful to the Director of the Oberwolfach Mathematical Research Institute Professor Dr M Barner and his staff for providing the facilities and to Dr G Baszenski Professor Dr F J Delves Dr H

Computation of Curves and Surfaces Wolfgang Dahmen, Mariano Gasca, Charles A. Micchelli, 2012-12-06 Assembled here is a collection of articles presented at a NATO ADVANCED STUDY INSTITUTE held at Puerto de la Cruz Tenerife Spain during the period of July 10th to 21st 1989. In addition to the editors of these proceedings Professor Larry L Schumaker from Vanderbilt University Nashville Tennessee served as a member of the international organizing committee. The contents of the contributions fall within the heading of COMPUTATION OF CURVES AND SURFACES and therefore address mathematical and computational issues pertaining to the display modeling interrogation and representation of complex geometrical objects in various scientific and technical environments. As is the intent of the NATO ASI program the meeting was two weeks in length and the body of the scientific activities was organized around prominent experts. Each of them presented lectures on his current research activity. We were fortunate to have sixteen distinguished invited speakers representing nine NATO countries: W Bohm Federal Republic of Germany C de Boor USA C K Chui USA W Dahmen Federal Republic of Germany F Fontanella Italy M Gasca Spain R Goldman Canada T N T Goodman UK J A Gregory UK C Hoffman USA J Hoschek Federal Republic of Germany A Le Mehaute France T Lyche Norway C A Micchelli USA L L Schumaker USA C Traas The Netherlands. The audience consisted of both young researchers as well as established scientists from twelve NATO countries and several non NATO countries.

Proceedings of the Second International Colloquium on Numerical Analysis D. Bainov, V. Covachev, 2020-05-18 No detailed description available for Proceedings of the Second International Colloquium on Numerical Analysis

Multivariate Approximation Theory II Schempp, Zeller, 1982-01-01

Multivariate Approximation Theory IV C. K. Chui, Walter Schempp, Karl Zeller, 1989

Multivariate Approximation Theory forms a rapidly evolving field in Applied Mathematics. The reason for its particular current interest lies in its impact on Computer Aided Geometric Design (CAGD) Image Processing Pattern Recognition and Multidimensional Signal Processing. Multivariate Bernstein polynomials and box splines for example play an important role in CAGD. Conversely the highly important filter bank design problem of signal processing for instance gives rise to a new family of multivariate approximating functions the Gabor wavelets with interesting technological and biological applications. The conferences on Multivariate Approximation Theory held at the Mathematical Research Institute at Oberwolfach Black Forest in 1976 1979 1982 1985 and 1989 reflect the progress made in this area and related fields. The present volume which is a continuation of the preceding volumes Constructive Theory of Functions of Several Variables Lecture Notes in Mathematics 571 1977 Multivariate Approximation Theory ISNM 51 1979 Multivariate Approximation Theory II ISNM 61 1982 Multivariate Approximation Theory III ISNM 75 1985 is based on the conference held on February 12-18 1989. It

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Topics in Numerical Analysis P.R. Turner, 2006-11-15 **Advances in Multivariate Approximation** Werner Haußmann, Kurt Jetter, Manfred Reimer, 1999-11-12 This volume deals with main results of the 3rd International Conference on Multivariate Approximation organized by the University of Dortmund Special emphasis is put on the following topics Interpolation and approximation on spheres and balls approximation by solutions of differential equations construction of node systems scattered data techniques Mathematical Methods for Curves and Surfaces II Morten Dæhlen, Tom Lyche, Larry L. Schumaker, 1998 Contains more than fifty carefully refereed and edited full length papers on the theory and applications of mathematical methods arising out of the Fourth International Conference on Mathematical Methods in Computer Aided Geometric Design held in Lillehammer Norway in July 1997

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