Cancun (Mexico), April 24~29, 2003

Third International Conference Multivariate Approximation : Theory and Applications

Informations :
http://lmi.insa-rouen.fr/~mata2003/

Conference topics :

The meeting will focus on various aspects of multivariate approximation.
This includes :

- Interpolation and approximation methods using splines, wavelets, radial basis function, orthogonal polynomials, etc...
- Mathematical imaging,
- Computer Mechanics Design...,

as well as various applications in scattered data fitting, Terrain modelling, meteorology, hydrology, surfaces offsets, Subdivision surfaces, image processing, robotics, trajectory prediction, solid modelling, curve and surface fitting, CAGD.

Organizers :

Christian Gout
Christophe Rabut
Leonardo Traversoni

In cooperation with :

AFA - SMAI
SIAM
SMAI
SMM
UAM (Iztapalapa)

Proceedings :

As a special issue of Numerical Algorithms (Kluwer)

PROGRAMME

Third International Conference on

Multivariate Approximation: Theory and Applications

at **Cancun (**WESTIN Regina Resort**), Mexico April 24-29, 2003.**

Index

Introduction

You will find in this program all the schedule of the conference, and some other information (abstracts, proceedings instructions, …).

Thank you for your participation in MATA 2003.

Scientific Committee

Dominique Apprato (Pau), Claude Brezinski (Lille), Mariano Gasca (Zaragoza), Christian Gout (Rouen), Tom Lyche (Oslo), Gregory Nielson (Arizona), Allan Pinkus (Tel Aviv), Christophe Rabut (Toulouse), Robert Schaback (Göttingen), Leonardo Traversoni (Mexico).

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– INSA de Toulouse
– INSA de Rouen
– Ministère de l'Education Nationale et de la Recherche, France
– SMAI - AFA
– SIAM
– SMM
– UAM (Iztapalapa)

Previous Conferences of the series:

First International Conference on Scattered Data Fitting
Cancun, Mexico, Thursday, March 2- Wednesday, March 8, 1995
Org. : A. Le Mehaute, L. L. Schumaker, L. Traversoni

Second International Conference on Multivariate Scattered Data Fitting
Puerto Vallarta, Jalisco, Mexico, April 15--20, 1999
Org. : P. Gonzalez-Casanova, A. Le Méhauté, L. L. Schumaker, L. Traversoni

<u>The proceedings</u>

<u>of the conference will be edited as a special issue of **Numerical Algorithms.**</u>

http://www.kluweronline.com/issn/1017-1398

<u>Some remarks:</u>

1) No difference will be made in the proceedings between an oral talk and a poster talk.

2) To appear in the proceedings, it will be necessary to have made the communication in Cancun.

3) The paper submitted to the proceedings must correspond to the talk presented in Cancun (though possibly actualized). No page limitation is given.

4) A peer review will be made. The process will be the same as a classical submission in the journal "Numerical Algorithms"... The authors will have to take into account the "instructions for authors" of this journal (http://www.kluweronline.com/issn/1017-1398). The editors (C.Gout-C. Rabut-L. Traversoni) will take their decision taking into account the reports made by the referees, and accordingly to Numerical Algorithms' policy.

5) Deadline, tex macros, and all information about the proceedings will be given on site. Electronic submission is preferred whenever possible.

Manuscript Presentation

1. Manuscripts must be written in English and typed on one side of the page only, with wide margins. A font size of 11 point is preferred. Manuscripts must include:
   - A *short title* which will be used together with author's names in the running headline.
   - The authors' *name and addresses*
   - A self-contained *abstract,* preferably without formulae
   - A list of *keywords*
   - AMS (MOS) *classification*
2. *Tables* and *figures* should be numbered, have a self-contained caption, and their positions in the text must be clearly indicated. In the case of paper-only submission, figures should be on separate sheets. In the case of electronic submission, please supply your figures in Encapsulated Postscript form.
3. *References* must be numbered. In the text, they should be indicated by a bracketed number (e.g. [1]).

   Bibliography Examples:
   Reference to a paper in a journal:
   [6] G.R. Kampen, Orienting planar graphs, Discrete Math 4 (1976), 134-144.
   To a book:
   [5] F. Haray, *Graph theory,* Addison-Wesley, 1969.
   To a paper in a contributed volume:
   [3] P.E. Bjorstad and O.B. Widlund, Solving ellipic problems on regions partitioned into substructures, in: *Elliptic Problem Solvers II* eds. G. Birkhoff and A. Schoenstadt, Academic Press, 1984, pp. 245-256.
   To a report or unpublished paper:
   [52] P. Vassilevski, Hybrid V-cycle algebraic multilevel preconditioners, Preprint, Bulgarian Academy of Sciences, Bulgaria, 1987.

April 24, THURSDAY	April 25, FRIDAY	April 26, SATURDAY	April 28, MONDAY	April 29, TUESDAY
8.00: Registration **8.30: Welcome session** **8.40 Jeremy Levesley** Where there's a Will there's a way The Life and Work of Will Light. **9.40 Rob A. Brownlee,** Approximation Orders for Interpolation by Surface Splines to Rough Functions. **10.10 Andrew Crampton** An Investigation into Novel Approximation Estimators **10.40 Marie-Laurence Mazure**, Blossoming stories **11.20 Mexican Coffee Break & Registration** **12.10 Gerald Farin** Splines over iterated Voronoi diagrams **12.50 Gudrun Albrecht** Tangent estimation with conic precision **13.20 Lucia Romani** The conversion matrix between non-uniform B-spline and Bézier representation **13.50 Victoria Hernandez** Sampling points on regular parametric curves with control of their distribution **14.30 END**	**8.00 Robert Schaback** Multivariate Interpolation by Polynomials as Limits of Radial Basis Functions **8.40 Laura Montefusco** Filling holes with Radial Basis Functions **9.10 Svenja Lowitzsch** Divergence free radial basis function applied to a Navier-Stockes Equation **9.40 Abdel Kouibia** Spline approximation of discontinuous parametric curves and surfaces with tangent conditions **10.10 Francis J. Narcowich** Error estimates for scattered-data interpolation via RBFs **10h50 Mexican Coffee Break** **11.40 Carole Le Guyader** The Level Set Method and Images Segmentation under Interpolation conditions **12.10 Miguel Pasadas** Construction of surfaces by smoothing PDE splines **12.40 Francesca Feraudi** An adaptive method for the selection of scattered data points **13.10 Miklos Hoffmann** Scattered data fitting by artificial neural network **13.40 Costanza Conti** Stationary and Non-Stationary Vector Subdivision Schemes **14.20 END**	**8.00 Mariano Gasca,** On bivariate polynomial interpolation **8.40 Jesus Carnicer,** Generation of lattices of points for bivariate interpolation **9.10 Alexey L. Sadovski,** Integration of Statistic and Harmonic Analysis to Predict Water Levels in the Estuaries and Shallow Waters of the Gulf of Mexico **9.40 Andras Kroo,** Markov and Jackson-type inequalities for multivariate polynomials on curves **10.10 Lidia Fernández Rodríguez**, Classical Orthogonal Polynomials in two variables: a matrix approach **10.40 Claude Brézinski** , Quasi-orthogonal polynomials **11h20 Mexican Coffee Break** **12h : END** **POSTER SESSION, Monday 10.50** - **Vitali Stassevich,** Wavelets and multiple 2D scattering problems by bodies - **Yuliya Babenko**, Olovyanishnkiov Inequality for Multivariable Functions - **Andrew Crampton**, Detecting and Approximating Fault Lines - **Christian Gout**, Segmentation under Geometrical Conditions Using Geodesic Active Contours and Interpolation Using Level Set Methods - **Francisco Javier Lopez Jaquez**, Multivariable Analysis Applied to Movement Control of a Four Degrees of Freedom Pick and Drop Robot - **Manuel A. Lopez Ramirez**, Quaternion Splines - **Antonio J. Lopez-Moreno**, Asymptotic expansion of multivariate Kantorovich type operators - **Juan M. Moreno**, On a certain class of multivariate operators - **Francesca Pitolli,** Some recent results on a class of bivariate refinable functions - **Christophe Rabut**, Approximation by using locally tensorial product splines - **Joel Suarez**, One-Dimensional One-Way Cellular Automata, Encoding and Polynomial Interval Maps. - **Jessica Tishmack**, Web-Based Water Level Predictions Along the Texas Coast Using Multivariate Statistical Modeling and Harmonic Analysis - **Maria Trujillo,** Combining K-means and Semi-variogram-Based Grid Clustering	**8.00 Sonia Gomes** Wavelets and adaptive grids for PDEs **8.40 Armin Iske** Multilevel Scattered Data Approximation **9.10 Oleg Davydov** Efficient computation of smooth Bézier surface approximations to scattered data. **9.40 Daniel Castano** Adaptive Data Fitting with Regularization based on B-Spline Wavelets **10.10 Eduardo Bayro Corrochano** Quaternion Wavelet Transform: Theory and Applications **10.50 Mexican Coffee Break and** **POSTER SESSION** **12.00 Angela Kunoth** On Adaptive Wavelet Methods **12.40 Rajiv Nekkanti** Wavelet based Solution to Time-Dependent Two Point Initial Boundary Value Problems with Non-Periodic Boundary Conditions involving High Intensity Heat and Mass Transfer in Capillary Porous Bodies **13.10 Alex P. Anyutin** Application of the wavelets in 2D scattering problems by screens **13.40 Gregory M. Nielson** Adaptive Surface Fitting to Point Cloud Data **14.20 END**	**8.00 Klaus Guerlebeck** On approximation by monogenic polynomials **8.40 Tatyana Sorokina** C^1 quintic splines on type- tetrahedral partitions **9.10 Vera Rayevskaya** Multi-sided Macro-Element Spaces Based on Clough-Tocher Triangle Splits **9.40 Leonardo Traversoni** Quaternionic approximation a tool for PDE solving **10.10 Qiaode Jeffrey Ge** Fine-Tuning of One- and Two-Parameter Spline Motions **10.50 Mexican Coffee Break** **11.40 Pedro Gonzalez Casanova** Radial Quasi interpolation in Compact polygonal Domains **12.10 Zack Bowles** Artificial Neural Network Predictions of Water Levels in a Gulf of Mexico Shallow Embayment **12.40 Thomas Bloom** Asymptotic distribution of nodes for polynomial interpolation on algebraic curves **13.10 Marco Paluszny** 3D Lemniscates: A CAGD primitive? **13.50 Farewell talk** **14.00 END OF CONFERENCE**

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8.00 Registration

8.30 Welcome Session

8.40 J. Levesley
Where there's a Will there's a way
The Life and Work of Will Light.

9.40 R. A. Brownlee, W. Light
Approximation Orders for Interpolation by Surface Splines to Rough Functions**.**

10.10 D. Jenkinson**,** J.C. Mason, **A. Crampton**, M.G. Cox
An Investigation into Novel Approximation Estimators

10.40 M.-L. Mazure,
Blossoming stories

11.20 Mexican Coffee Break & Registration

12.10 G. Farin
Splines over iterated Voronoi diagrams

12.50 G. Albrecht, J.P. Bécar, G. Farin, D. Hansford
Tangent estimation with conic precision

13.20 G. Casciola**, L. Romani**
The conversion matrix between non-uniform B-spline and Bézier representation

13.50 V. Hernandez, J. Estrada Sarlabous
Sampling points on regular parametric curves with control of their distribution

14.30 END

APRIL 25, FRIDAY

8.00 R. Schaback
Multivariate Interpolation by Polynomials as Limits of Radial Basis Functions

8.40 L. Montefusco, D. Lazzaro, S. Morigi
Filling holes with Radial Basis Functions

9.10 S. Lowitzsch
Divergence free radial basis function applied to a Navier-Stockes Equation

9.40 A. Kouibia, M. Pasadas
Spline approximation of discontinuous parametric curves and surfaces with tangent conditions

10.10 F. J. Narcowich
Error estimates for scattered-data interpolation via RBFs

10h50 Mexican Coffee Break

11.40 C. Le Guyader, D. Apprato, C. Gout
The Level Set Method and Images Segmentation under Interpolation conditions

12.10 M. Pasadas, M.L. Rodriguez
Construction of surfaces by smoothing PDE splines

12.40 F. De Tisi, **F. Feraudi**
An adaptive method for the selection of scattered data points

13.10 M. Hoffmann
Scattered data fitting by artificial neural network

13.40 C. Conti
Stationary and Non-Stationary Vector Subdivision Schemes

14.20 END

APRIL 26, SATURDAY

8.00 M. Gasca, J. Carnicer
On bivariate polynomial interpolation

8.40 J. Carnicer, M. Gasca
Generation of lattices of points for bivariate interpolation

9.10 A. L. Sadovski, P. Michaud, C. Steidley, J. Tishmack, K. Torrès
Integration of Statistic and Harmonic Analysis to Predict Water Levels in the Estuaries and Shallow Waters of the Gulf of Mexico.

9.40 A. Kroo
Markov and Jackson-type inequalities for multivariate polynomials on curves

10.10 L. Fernández Rodríguez, T. Pérez, M. A. Piñar
Classical Orthogonal Polynomials in two variables: a matrix approach

10.40 C. Brézinski, K.A. Driver, M. Redivo Zaglia
Quasi-orthogonal polynomials

11.20 Mexican Coffee Break

12.00 END

APRIL 27, SUNDAY

Group excursion to Chitzen Itza (or Tulum),

if sufficiently many people are interested

APRIL 28, MONDAY

8.00 S. Gomes
Wavelets and adaptive grids for PDEs

8.40 A. Iske, J. Levesley
Multilevel Scattered Data Approximation

9.10 O. Davydov
Efficient computation of smooth Bézier surface approximations to scattered data

9.40 D. Castano
Adaptive Data Fitting with Regularization based on B-Spline

10.10 E. Bayro Corrochano, J.F. Alvarado Casas
Quaternion Wavelet Transform: Theory and Applications

10.50 Mexican Coffee Break & POSTER SESSION

POSTER SESSION

- **A.P. Anyutin - V.I. Stasevich,**
Wavelets and multiple 2D scattering problems by bodies

- V. Babenko, **Y. Babenko**,
Olovyanishnkiov Inequality for Multivariable Functions

- **A. Crampton**, J.C. Mason,
Detecting and Approximating Fault Lines

- **C Gout**, C. Le Guyader, L. Vese,
Segmentation under Geometrical Conditions Using Geodesic Active Contours and Interpolation Using Level Set Methods

- **F. J. Lopez Jaquez**, Multivariable Analysis Applied to Movement Control of a Four Degrees of Freedom Pick and Drop Robot

- **M. A. Lopez Ramirez**,
Quaternion Splines

- **A.-J. Lopez-Moreno** & F.-J. Muñoz-Delgado
Asymptotic expansion of multivariate Kantorovich type operators

- **J. M. Moreno**, J.M. Quesada
On a certain class of multivariate operators

- C. Conti, L. Gori, **F. Pitolli**
Some recent results on a class of bivariate refinable functions

- **C. Rabut**,
Approximation by using locally tensorial product splines

- **J. Suarez**,
One-Dimensional One-Way Cellular Automata, Encoding and Polynomial Interval Maps.

- **J. Tishmack**, K. Torres, A. Mostella, P. Michaud, A. Sadovski, C. Steidley,
Web-Based Water Level Predictions Along the Texas Coast Using Multivariate Statistical Modeling and Harmonic Analysis

- **M. Trujillo**, E. Izquierdo
Combining K-means and Semivariogram-Based Grid Clustering

12.00 A. Kunoth
On Adaptive Wavelet Methods

12.40 H.N. Narang, **R. Nekkanti**
Wavelet based Solution to Time-Dependent Two PointInitial Boundary Value Problems with Non-Periodic…..

13.10 A.P. Anyutin – V. I. Stasevich
Application of the wavelets in 2D scattering problems by screens

13.40 G. M. Nielson
Adaptive Surface Fitting to Point Cloud Data

14.20 END

APRIL 29, TUESDAY

8.00 K. Guerlebeck
On approximation by monogenic polynomials

8.40 L.L. Schumaker, **T. Sorokina**
C^1 quintic splines on type- tetrahedral partitions

9.10 V. Rayevskaya, L.L. Schumaker
Multi-sided Macro-Element Spaces Based on Clough-Tocher Triangle Splits

9.40 L Traversoni
Quaternionic approximation a tool for PDE solving

10.10 Q. J. Ge
Fine-Tuning of One- and Two-Parameter Spline Motions

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Radial Quasi interpolation in Compact polygonal Domains

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Artificial Neural Network Predictions of Water Levels in a Gulf of Mexico Shallow Embayment

12.40 T. Bloom
Asymptotic distribution of nodes for polynomial interpolation on algebraic curves

13.10 M. Paluszny
3D Lemniscates: A CAGD primitive?

13.50 Farewell talk

14.00 END OF THE CONFERENCE

LIST OF PARTICIPANTS

The 58 registered participants come from 14 different countries.

Belgium (1): Thiran **Brazil (1):** Gomes. **Canada (1)** : Bloom **Cuba (1):** Hernandez **France (6):** Albrecht, Apprato, Brézinski, Gout, Le Guyader, Rabut **Germany (6):** Castano, Davydov, Guerlebeck, Iske, Kunoth, Schaback **Hungary (2):** Hoffmann, Kroo **Italy (6):** Conti, De Tisi, Feraudi, Montefusco, Pitolli, Romani **Mexico (6):** Bayro, Gonzalez, Lopez Jaquez, Lopez Ramirez, Suarez, Traversoni **Russia (2)**: Anyutin, Stassewich **Spain (7):** Carnicer, Fernandez, Gasca, Kouibia, Lopez, Moreno, Pasadas **United Kingdom (5):** Brownlee, Crampton, Hunt, Jenkinson, Levesley, Trujillo **USA (13):** Babenko, Bowles, Farin, Futamura, Ge, Lowitzsch, Narcowich, Nekkanti, Nielson, Rayevskaya, Sorokina, Sadovski, Tishmack **Venezuela (1):** Paluszny. **?** : Mc Kelligan

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Application of the wavelets in 2D scattering problems by screens

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Key-Words: - Haar and Battle-Lemarie wavelets, Fredholm integral equations (or a system equations) of fist kind with singular kernel.

One of the most attractive ideas was appeared in last years had been connected with utilizing of wavelets as basis functions in method of the moments. It is evident that wavelets technique allows to create a very fast algorithms then ordinary one due to applying a specific attributes of its as a basis functions. It is well known too that many of diffraction problems could be reduced to integral equations of the different kind (with singular kernel or with smooth kernel) and method of moments was widely used for its solving.

This paper is concerned the extending wavelets technique and developed “prolonged” boundary condition for solving a currents integral equations and system of currents integral equations, which could be presented as a Fredholm integral equations of the first kind with singular kernals. In this case the unknown function is current (-or currents) on the surface of the scatterer (-or scatterers) and it is presented in form of set with Haar or linear Battle-Lemarie wavelets function. The results of utilizing wavelets technique are illustrated by solving of a Dirichlet, Neumann boundary scattering problems by perfect conducting band (-or system of M bands), corner and parabolic antennas. It were considered a plane and cylindrical incident waves. It was shown that approximation of the current with Haar wavelet gives numerical result stable with high accuracy and Haar wavelet gives much more accuracy for scattering pattern then linear Battle-Lemarie wavelets.

Wavelets and multiple 2D scattering problems by bodies

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Key-Words: - Haar wavelets, linear Battle-Lemarie wavelets, Fredholm integral equations of fist kind, 2D multiple scattering problem.

A multiple scattering by 2D cylindrical structure is the classical problem of the diffraction theory and it has been under discussing since the middle of 20th century.

This paper is concerned some numerical aspects of this problem deal with extending wavelets technique for solving a system of auxiliary currents integral equations, These integral equations are the Fredholm integral equations of fist kind with smooth kernels and it's unknown functions are an auxiliary currents on some auxiliary surfaces (contour) Σ_j located within (-or outside) the scattering surface (contour) S_j. Each auxiliary current is presented in form of set with Haar wavelet functions or linear Battle-Lemarie wavelets and procedure of algebraisation was applied for obtaining a system of M algebraic equations. The problem of choosing and location of the auxiliary surfaces (contour) Σ_j was developed on the base of analytical transformation for original surfase (contour). The results of utilizing wavelets technique are illustrated by solving 2D scattering problems by cylinders structures of M cylinders with ellipse or multifoil cross-section (contours). It was shown that developed analytical transformation for original surfase (contour) and approximation of auxiliary current with Haar wavelet gives numerical result stable with high accuracy and Haar wavelet gives much more accuracy for scattering pattern then linear Battle-Lemarie wavelets.

Olovyanishnkiov Inequality for Multivariable Functions

Vladislav Babenko, Yuliya Babenko

In 1951 Olovyanishnikov proved the analog of Kolmogorov's inequality for $r-$monotone functions defined on the half-line. We will present the generalization of his result to the case of $r-$monotone functions of many variables. Let $\mathrm{R^d}_- = \{(x_1, \cdots, x_d) \in \mathrm{R^d} : \mathrm{x_1} \leq 0, \cdots, \mathrm{x_d} \leq 0\}$. We will say that the function x on $\mathrm{R^d}_-$ belongs to the class $L_\infty^{(r,0,\cdots,0)}(\mathrm{R^d}_-)$ if for any fixed values of the last $d-1$ variables, the derivative of the $(r-1)$ order with respect to the first variable is locally absolutely continuous, and the derivative of order r is essentially bounded. As $L_\infty^{(r,0,\cdots,0),+}(\mathrm{R^d}_-)$ we shall denote a class of functions x from $L_\infty^{(r,0,\cdots,0)}$ positive on the whole domain of definition and monotone with respect to the first variable (for the fixed value of the last $d-1$ variables) up to the order r including.

Set the family of functions $\varphi_r(t)$ as the following

$$\varphi_r(t) = \begin{cases} 0, & -\infty < t \leq -1 \\ \frac{(t+1)^r}{r!}, & -1 \leq t \leq -0 \ . \end{cases} \tag{1}$$

Theorem 1 *Let φ_r be a function of the type in (1). For any function x on $\mathbf{R}_-^d$ such that $x^{(k_1,\cdots,k_d)} \in L_\infty^{(r-k_1,0,\cdots,0),+}(\mathbf{R}_-^d) \cap \cdots \cap L_\infty^{(0,\cdots,0,r-k_d),+}(\mathbf{R}_-^d)$,*
and such that $x(u_1, \cdots, u_d) \to 0$ when at least one of $u_i \to \infty$ the following inequality holds true

$$\left\|x^{(k_1,\cdots,k_d)}\right\|_\infty \leq \frac{\|\varphi_{r-k}\|_\infty}{\|\varphi_r\|_p^{\frac{r-k}{r}}} \|x\|_\infty^{\frac{r-k}{r}} \left\|x^{\left(r-\sum\limits_{i\neq 1} k_i, k_2, \cdots, k_d\right)}\right\|_\infty^{\frac{k_1}{r}} \cdots \left\|x^{\left(k_1,\cdots,k_{d-1}, r-\sum\limits_{i\neq d} k_i\right)}\right\|_\infty^{\frac{k_d}{r}} \tag{2}$$

where $k := \sum\limits_{i=1}^{d} k_i < r$ and $k_i > 0, \forall i$.

Inequality (2) is exact.

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Quaternion Wavelet Transform: Theory and Aplications

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This work presents the basics and the practicalities of the Quaternion Wavelet Transform (QWT). We start with a review of the real valued wavelet transform and the Complex Wavelet Transform (CWT). We show how the QWT is generalized. Along the same lines of Mallat, we developed a pyramidal model to disentangle symmetries of 2D signals (images) in the quaternion algebra, getting for each level one approximation and three decompositions (horizontal, vertical and diagonal). As expected this provides a richer representation of images, which gives us a more e.cient method for image analysis and processing. In the literature the QWT belongs to the theoretical arena where the used quaternion mother wavelet is the Haar function which is a very inefficient kernel. In this work we go beyond that using quaternion Gabor filters as kernels and the quaternionic phase concept for building a pyramid of phases with different resolution. In the experimental part we show a hierarchical region-based matching algorithm using discrete QWT to reconstruct optical flow and 3D reconstruction.

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Asymptotic distribution of nodes for polynomial interpolation on algebraic curves

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Let X be an algebraic curve in C^N : $N>1$. Let m_d denote the dimension of the space of polynomials of degree $\leq d$ on C^N restricted to X. Let K by a compact (non-polar) subset of X and $A_{d_j} : j=1,...m_d$ be an array of nodes in K.

The array is ``good" if $\lim_{(d\to\infty)} \lambda_{d^{1/d}} \leq 1$ where λ_d is the Lebesgue constant for polynomial interpolation at $A_{d_j} : j=1,...,m_d$ (An example of such an array is given by the Fekete points). We show that for any good array the sequence of normalized counting measures $\upsilon_d := \frac{1}{m_d}\sum_{j=1}^{m_d} \delta A_{d_j}$ converges (weak *) to be a measure μ with ${\rm supp}(\mu)\subset\partial K$.

For X of genus 0, the above result is due to Gotz, Maymeskul and Saff (Const. Approx. 2001) where a rational parametrization of X was used to reduce to a weighted problem in one variable.

For the results above, we use concepts from pluripotential theory.

Artificial Neural Network Predictions of Water Levels in a Gulf of Mexico Shallow Embayment

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In most coastal regions tide tables are the method of choice for water level predictions. In the United States, the National Ocean Service uses harmonic analysis and time series of previous water levels to compute tidal tables. For most locations along the US coast this method is adequate. However, for many locations along the coast of the Gulf of Mexico tide tables do not meet NOS criteria. Wind forcing has been recognized as the main variable not included in harmonic analysis. Performance of the tide chart is particularly poor in shallow embayments along the coast of Texas. Recent research at Texas A&M University-Corpus Christi has shown that Neural Network models including input variables such as previous water levels, tidal forecasts, wind speed, wind direction, wind forecasts and barometric pressure can greatly improve over the tide charts at several coastal locations. In this work we compare the Neural Network modeling technique for a station in Rockport, Texas, near Corpus Christi, Texas, against the NOS tide charts and the persistence model for the years 1997 to 2001. The Rockport station is ideal because it is located in a shallow embayment along the Texas coast and has a historical record of water levels and meteorological data in the Texas Coastal Ocean Observation database for the past 11 years. The performance of the Neural Network model is measured using NOS criteria such as Central Frequency (CF of 15 cm), Maximum Duration of Positive Outliers (MDPO), and Maximum Duration of Negative Outliers (MDNO). The NN model compares favorably against existing models using these criteria and is a better predictor of future water levels. Over this time span of 1997 – 2001 the tide tables have a CF of 85%, an MDPO of 16 hours, and an MDNO of 72.8 hours. The performance of the persistence model for a 24-hour prediction includes a CF of 95.8%, an MDPO of 14 hours, and an MDNO of 0.6 hours while the application of the Neural Network model leads to a CF of 96.9%, an MDPO of 5.9 hours, and an MDNO of 9.5 hours. The performance of the models is also compared during the 2002 tropical seasons, which included the passage of several tropical storms and hurricanes in the Gulf of Mexico.

Quasi--orthogonal polynomials

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The family of orthogonal polynomials P_n is defined by the orthogonality conditions

$$\int_a^b x^k P_n(x) w(x) dx = 0 : k = 0, \ldots, n-1,$$

where *w* is a positive weight function on the finite or infinite interval *[a,b]*. P_n is the polynomial of degree *n* belonging to the family of orthogonal polynomials on *[a,b]* with respect to the weight function *w*.

It is well known that the zeros of P_n are all real and distinct, lie in the interior *(a,b) of [a,b]*, and interlace with those of P_{n+1} and P_{n-1}.

When the orthogonality conditions are satisfied only up to *n-r-1* with $r \geq 1$, the polynomials are called <u>quasi--orthogonal of order</u> *r* and some of their zeros escape from the interval *[a,b]*.

In this talk, new results on the location of the zeros of quasi--orthogonal polynomials are given in the cases *r=1 and r=2.*

Then, these results are applied to Gegenbauer, Jacobi and Laguerre polynomials which are orthogonal with respect to weight functions depending on parameters. When the restrictions on these parameters are not satisfied, we prove that the polynomials are quasi--orthogonal. The corresponding weight functions are investigated and the location of their zeros is discussed.

Approximation Orders for Interpolation by Surface Splines to Rough Functions

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flushleft In this talk we consider the approximation of functions by radial basic function interpolants. There is a plethora of results about the asymptotic behaviour of the error between appropriately smooth functions and their interpolants, as the interpolation points fill out a bounded domain in $\mathbb{R}^d$. In all of these cases, the analysis takes place in a natural function space dictated by the choice of radial basic function – the native space. In many cases, the native space contains functions possessing a certain amount of smoothness. We address the question of what can be said about these error estimates when the function being interpolated fails to have the required smoothness. These are the rough functions of the title.

Generation of lattices of points for bivariate interpolation

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Principal lattices in the plane are distributions of points particularly simple to use Lagrange, Newton or Aitken-Neville interpolation formulas. Principal lattices were generalized by Lee and Phillips in 1991, introducing three-pencil lattices, that is, points which are the intersection of three lines, belonging to each of the three pencils. In this contribution, a semicubical parabola is used to construct lattices of points with similar properties. However, the lattices generated by this construction are not three-pencil lattices.

Adaptive Data Fitting with Regularization based on B-Spline Wavelets

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Abstract: A set of irregularly distributed points is fitted to a Least-Squares approximating surface constructed as linear combination of wavelets. The construction proceeds adaptively on a coarse-to-fine refinement. We discuss by numerical experiments the efficiency of the method in relation to iterative solution procedures. Furthermore, we present extensions of the method that allow to cope with wrong measurements (robust fitting) and to control the smoothness of the reconstruction by wavelet-adapted regularization methods.

Stationary and Non-stationary Vector Subdivision

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Subdivision schemes are efficient computational means for generating recursively denser and denser sequences of points in $\RR^d$. At each step of the subdivision recursion a new sequence of points is obtained simply by averaging the previously computed points. The average coefficients form the so-called *refinement mask*. If the averaging rules do not depend on the recursion level the scheme is said to be *stationary*, *otherwise non-stationary*. Furthermore, if the refinement coefficients are real numbers then we speak of a *scalar subdivision scheme* and, if the scheme has matrix coefficients, of *a vector subdivision scheme*. Subdivision schemes with matrix masks play an important role in the analysis of multivariate subdivision schemes, in the analysis of Hermite-type subdivision schemes or in the context of multiwavelets.

One of the difficult tasks when dealing with subdivision schemes is to prove their convergence and to investigate the smoothness of the associated limit function. In the last two decades many authors have investigated the convergence and the regularity of vector subdivision schemes. This has been mainly done by studying the properties of the transition operator ([4],[6]), of the joint spectral radius ([1],[3]) and of difference operators ([2],[5]) under particular assumptions on the refinement mask.

We start the talk by recalling some basic facts about stationary and non-stationary vector subdivision schemes. Then, we investigate the convergence of multivariate vector subdivision schemes with matrix masks as general as possible using the difference operator approach. In particular, we show how the derived difference and divided difference subdivision schemes can be used to study the convergence of the original subdivision scheme and the differentiability of the associated limit function.

[1] D.R. Cheng, R.Q. Jia, S.D. Riemenschneider, Convergence of Vector Subdivision Schemes in Sobolev Spaces, {\sl Appl. and Comp. Harm. Anal.} 12 (2002), 128-149.
[2] N. Dyn and D. Levin, Matrix subdivision-analysis by factorization, in: Approximation Theory, B.~D.~Bojanov, ed., DARBA, Sofia, (2002), 187-211.
[3] R.Q. Jia, S.D. Riemenschneider, and D.X. Zhou, Smoothness of Multiple Refinable Functions and Multiple Wavelets, SIAM J. Matrix.Anal.Appl. 21,(1999), 1-28.
[4] Q.T. Jiang, Multivariate matrix refinable functions with arbitrary matrix, Trans. Amer. Math. Soc. 351, (1999), 2407- 2438.
[5] C.A. Micchelli and T. Sauer, Regularity of Multiwavelets, Adv. Comp. Math. 7, (1997), 455--545.
[6] Z. Shen, Refinable Functions Vectors, SIAM J. Math. Anal. 29,1, (1998) 235-250.

Detecting and Approximating Fault Lines

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Abstract

The study of fault lines is an important one in fields such as geology and oceanography where it is necessary to trace out their paths or monitor their gradual movement over a period of time. In most cases, the area in which a fault might lie can only be mapped at a finite number of discrete points. These points must then be used to recreate an accurate representation of the fault line in the xy-plane. Several methods have already been studied [**?**, **?**] and suggest ways in which points lying close to a fault line can be detected. These methods also show how polygonal representations of the fault can be reconstructed from the detected points in the xy-plane.

In this study, we present two new methods that compliment and extend those already suggested. Firstly we present a curvature based method to locate the points that lie within some neighbourhood of the fault line. The main advantage of this method is its ability to provide accurate information very quickly. Unlike previous detection algorithms, there is no need to construct local interpolants over the data.

Secondly, we construct a smooth curve of the form $y = f(x)$ in the xy-plane to model the fault line. Because the data is potentially noisy, we propose an efficient linearised support vector machine (SVM) algorithm, using a cubic radial basis kernel, to model the fault. Here the main advantage is that a smooth rather than polygonal curve is constructed and the direction (or shape) of the curve in the xy-plane is affected only by the data and not by the triangulation method used in the detection algorithm.

Efficient computation of smooth Bézier surface approximations to scattered data.

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We discuss recent improvements in the scattered data techniques based on a two-stage method, where

1) reliable discrete least squares approximations (polynomial or non-polynomial) to the local fragments of the data are computed with the control of the norming constant, and then
2) they are extended to a smooth Bézier surface, with linear total computational cost. Applications to real world remote sensing data will be demonstrated. One-Dimensional One-Way Cellular Automata, Encoding and Polynomial Interval Maps.

Splines over iterated Voronoi diagrams

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We generalize B-spline curves to higher dimensions. We first observe that Sibson's nearest neighbor interpolant is the natural generalization of piecewise linear interpolation to higher dimensions. Next we note that repeated piecewise linear interpolation, via the de Boor algorithm, is the main constructive tool for B-spline curves. Combining both concepts, we present a method which uses repeated Sibson interpolation where the control mesh is based on the concept of iterated Voronoi diagrams of the input abscissae points. The resulting multivariate splines enjoy many of the properties of B-spline curves.

An adaptive method for the selection of scattered data points

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The problem of the approximation of surfaces from scattered data comes from different branches of science. Many applications require data fitting to such large scattered data sets, that some data filtering strategy needs to be applied to reduce the given input data, in order to obtain a good reproduction of the surface at low computational cost and with a fast evaluation of the solution. On the other hand in many other applications the obtainment of the data is very expensive both in terms of time and in terms of money, so that an idea of where to try to get the data could be useful in order to limit the costs. Having in mind, the second situation we propose a method for the selection of the data points as follows: starting from a first raw distribution of data points, we can estimate the gradient of the surface at each of these data points as well as at any other point; the method is based on the search of the areas where the gradients are maximum and where the sudden change of gradient are detected, so that it is possible to look for more data points only in these areas; finally the approximating surface is obtained by a local least squares polynomial approximation to scattered data technique. The proposed method can be successfully applied also in thinning of large sets of scattered data as explained in the paper, without any triangulation of the data. Numerical results show how it is possible to obtain good reproduction of surface with a low number of input points.

On bivariate polynomial interpolation

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March 18, 2003

Natural lattices were defined by Chung and Yao in the 70's as the sets of the $\binom{n+2}{2}$ intersection points of $n+2$ straight lines in general position. They are the simplest examples of configurations of points satisfying the GC condition, that is sets of points which give rise to a unisolvent Lagrange interpolation problem in the space of bivariate polynomials of degree n and can be solved by a very simple Lagrange interpolation formula. We extend this definition allowing parallel lines, multiple concurrences of lines, even coincidences of lines. The interpolation problem becomes a Hermite problem and the interpolation space is the subspace of polynomials of degree n whose degree decreases along the directions of the parallel lines . A Newton approach is much more efficient than the Lagrange formula for constructing the solution.

On the other hand we discuss the use of Lagrange, Newton and Aitken-Neville formulas for sets of points satisfying the GC condition.

Classical Orthogonal Polynomials in two variables: a matrix approach

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Orthogonal polynomials in two variables constitute an old subject in approximation theory (see [3]). Classical orthogonal polynomials in two variables are usually studied as solutions of second order partial differential equations (see [1], [2]). In this work, we study two-variable orthogonal polynomials associated to a moment functional u satisfying the two-variable analogue of the Pearson differential equation

$$\nabla^t(\phi u) = \psi^t u$$

where

$$\phi = \begin{pmatrix} A & B \\ B & C \end{pmatrix}, \psi = \begin{pmatrix} \psi_1 \\ \psi_2 \end{pmatrix}$$

are polynomial matrices such that A, B and C are polynomials of total degree ≤ 2, ψ_1, ψ_2 are polynomials of total degree ≤ 1, and ∇ is the usual gradient operator.

From this matrix approach we derive the extension of some of the usual characterizations of the classical orthogonal polynomials in one variable.

References

[1] Dunkl, C.F., Xu, Y., *Orthogonal Polynomials of several variables*, Encyclopedia of Mathematics and its Applications 81. Cambridge University Press, 2001.

[2] Kim, Y.J., Kwon, K.H., Lee, J.K., *Partial differential equations having orthogonal polynomial solutions*, J. Comput. Appl. Math. 99 (1998) 239-253.

[3] Krall, H.L., Sheffer, I.M., *Orthogonal polynomials in two variables*, Ann. Mat. Pura Appl. Serie 4 76 (1967) 325-376.

Fine Tuning of One- and Two-Parameter Spline Motions

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Abstract

This paper presents brings together the fields of kinematics and computer aided geometric design (CAGD) and presents several algorithms for fine-tuning of one- and two-parameter rational spline motions. The one- and two-parameter spline motions are represented by rational B-spline curves and surfaces in dual-quaternion space, respectively. The problems of fine-tuning of these motions are studied as those of fine-tuning of B-spline curves and surfaces. For fine-tuning of one-parameter motions, this paper presents a path-smoothing as well as a speed-smoothing algorithm. The path smooth algorithm automatically detects and smoothes out the third order geometric discontinuities in the path of the motion. The speed-smoothing algorithm uses a higher degree motion to obtain a second-order geometric approximation of the path of a lower-degree rational B-spline motion while allowing specification of the speed and the rate of change of speed at the key points to obtain a near constant kinetic energy parameterization. The notion of kinetic energy is used in the paper as a natural way of combining the rotational and translational speed of a spatial motion. This paper also explores ways to extend shape fine-tuning and improvement methods in CAGD to two-parameter B-spline motions. The results have applications in trajectory generation in robotics, planning of camera movement, spatial navigation in visualization and virtual reality systems, as well as mechanical system simulation.

Wavelets and Adaptive Grids for PDEs

by

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Solutions to many interesting flow problems frequently exhibit singular features, such as sharp transition layers, propagating steep fronts or pronounced spikes, whose reliable numerical approximation requires challenging computational tasks. Uniform gridding is not practical, since high resolution is only needed in small regions, where irregularities occur. Therefore, significant improvements in computational efficiency may be obtained by authomatically adapting the grid in which the discretization of the solution is performed. In computational fluid dynamics, there are several approaches for the construction of such adapted meshes. Nowadays, a new kind of adaptive criteria is becoming useful. The decision whether the grid is refined or unrefined at a certain location is taken according to the magnitude of wavelet coefficients, which are indicators for local smootheness of the numerical solution.

The main purpose of the talk is to give an overview of recent results illustrating the performance of adaptive wavelet strategies when combined with traditional schemes. One attractive aspect of such adaptive solvers is that they can be separated into two parts: the operator part and the representation part. The representation part is formulated in the context of wavelet data compression. The operator part is performed by a standard scheme that may be chosen by means of stability and consistency criteria. Therefore, the solver can be beneficiary of considerable advances achieved in both areas. Numerical examples shall be presented concerning the use of wavelets for adaptive calculations in finite differences, finite volumes and discontinuous Galerkin method.

Radial Quasi interpolation in Compact Polygonal Domains

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Abstract

In this talk we introduce a bell-shape quasi interpolant which is capable of approximating an unknown function *at any point* of a given compact set in $\Omega \subset \mathbb{R}^2$ with convex polygonal boundary. The quasi interpolant is build from a set of scattered data centers, whose triangulation forms a cover of Ω. We thus construct a new numerical scheme which is able to approximate the unknown function at the boundary. This quasi interpolant is built from mean value integral functionals on disks, whose centers are placed at the original (x_i, y_i) data values. Since these functionals are bounded for piecewise discontinuous functions, the quasi interpolant is able to approximate these type of discontinuities without presenting oscillations. By using tests functions, we perform a numerical evaluation which verifies the former assertions. Also, for smooth enough functions we obtain the optimal order of convergence of this scheme in the standard Sobolev norms.

These results may be of significant importance for the numerical solution of non-linear differential equations in two dimensions. On the one hand the quasi interpolant is able of approximating jumps without presenting oscillations and on the other hand since the approximation can be computed independently in compact sub-domains, a domain decomposition algorithm may be suitable to be implemented.

Segmentation under Geometrical Conditions Using Geodesic Active Contours and Interpolation Using Level Set Methods.

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Let I: $\Omega \to IR$ be a given bounded image function, where Ω is an open and bounded domain which belongs to IR^n. Let us consider $n = 2$ for the purpose of illustration. Also, let $S = (x_i) \in \Omega$ be a finite set of given points. We would like to find a contour $\Gamma \subset \Omega$, such as Γ is an object boundary interpolating the points from S.

We combine the ideas of the geodesic active contours {cf. Caselles Kimmel Sapiro 1997} and of interpolation of points {cf. Zhao Osher Merriman Kang 2000} in a Level Set approach introduced by Osher & Sethian (1988). We present the modelling of the proposed method, a theoretical study (viscosity solution) and its corresponding algorithm.

On approximation by monogenic polynomials

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We consider spaces of monogenic (or hyperholomorphic) functions. Monogenic functions are defined as solutions of the homogeneous Dirac equation or as solutions of a generalized Cauchy-Riemann system. It will be shown at the beginning how solutions to elliptic boundary value problems can be expressed in terms of monogenic functions. This motivates the task to look for efficient approximations of monogenic functions. We refer shortly to approximations based on shifted fundamental solutions for approximations in the complement of a bounded domain. In bounded domains we discuss monogenic polynomials. These polynomials can be defined directly or related to spherical harmonics. The rate of convergence and the stability of such approximations will be considered for several polynomial systems. Based on these results we are able to characterize weighted function spaces of monogenic functions by their Taylor or Fourier coefficients, respectively. The problem to find a regular monogenic primitive (with respect to a hyperholomorphic derivative) of a monogenic function can be solved. At the end the developed theory will be applied to construct integral free representation formulas for the solutions to some boundary value problems.

Sampling points on regular parametric curves with control of their distribution

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The parametric representation is the most common way of describing curves in CAGD and related areas dealing with geometric properties of objects. In order to generate a sequence of points on a curve with control of their distribution it would be ideal to have the arc length parametrization of the curve. Nevertheless, since the direct computation of the arc length parametrization happens to be expensive, several authors propose efficient methods to compute approximate arc length parametrizations.
In this talk, we present an iterative algorithm to generate a sequence of a prescribed number of points on a parametric curve with control of their distribution. The proposed algorithm depends on a free parameter which rules the achievement of a final distribution of points lying between two extreme cases: uniform arc length distribution and bending energy dependent distribution. This is obtained by computing a reparametrization function that interpolates the inverse of the arc length function and its derivative at equidistant arguments. The proposed repametrization function is a C^1 rational linear spline, therefore if the original curve is a NURBS, then the reparametrized curve is also a NURBS of the same degree. We prove that for generating a sequence of points with uniform arc length distribution our algorithm converges quadratically. Moreover, the repametrization obtained as a byproduct of the algorithm agrees with the arc length parametrization at a finite set of points.
In the numerical solution of partial differential equations an important problem is the generation of a grid on the domain, in order to approximate the differential operator. Usually, the boundary of the region is described by a parametric closed curve. The shape of the boundary cells strongly depends on the position of the grid points lying on the boundary curve. Therefore, having a control of the distribution of these points is crucial for getting a grid with optimal properties.
In this talk, we also present an application of our algorithm for generating the grid points on the boundary curve. First, we approximate the boundary of the plane region with a C^1 conic spline curve and since our algorithm also works for C^1 spline curves, we use the C^1 reparametrization to generate points on the boundary curve with control of their distribution.
Keywords: Parametric curves, Arc length parametrization, Sampling points, Rational linear reparametrization.

Scattered data fitting by artificial neural network

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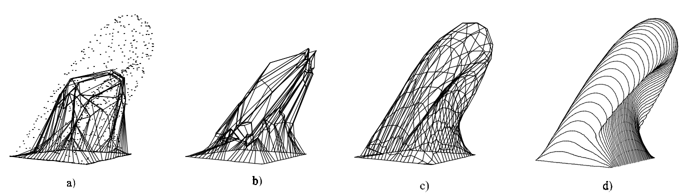
Scattered data fitting is one of the central problems in computer aided design. One can find numerous methods for approximation of scattered data or updating existing surfaces by scattered points using space warping, NURBS, subdivision or algebraic surfaces (see [1] and references therein for a general overview of the problem). In terms of NURBS surfaces the crucial point of these methods is the parametrization of the given data that is to assign a value to each point, where several restrictions and assumptions have been introduced. One can try to consider the assigned values as unknown parameters in an optimization problem, but for large amount of data this approach leads to a complex non-linear system with several unknowns (see also [1]). At the recently developed base surface method data points are projected onto a predefined parametric surface to find the corresponding parameter value (c.f. [2], [3]). This technique can work well for certain type of data, but there are several conditions in terms of creating the base surface and the projection has to be a function, i.e. no overlapping allowed. Sometimes it is quite difficult to find a base surface which satisfies all the conditions.

This paper is devoted to the neural network approach of scattered data fitting. We create or modify different types of surfaces by Kohonen neural network in an iterative way. The quality of approximation can be controlled by the number of iteration steps and by other numerical parameters. The obtained surface can be used as a coarse approximant or as a base surface for further process. This way one can create base surfaces for more general types of data sets than by earlier approaches. The method is based on the author's previous work ([4], [5]).



References

[1] Várady T., Martin R.R. and Cox J., Reverse engineering of geometric models - an introduction, *Computer -Aided Design*, **29** (1997) 255–268.

[2] Ma W., He P., B-spline surface local updating with unorganized points, *Computer-Aided Design*, **30** (1998) 853–862.

[3] Piegl L., Tiller W., Parametrization for surface fitting in reverse engineering, *Computer-Aided Design*, **33** (2001) 593–603.

[4] Hoffmann M., Várady L., Free-form surfaces for scattered data by neural networks, *Journal for Geometry and Graphics* **2** (1998) 1–6.

[5] Várady L., Hoffmann M., Kovács E., Improved free-form modeling of scattered data by dynamic neural networks, *Journal for Geometry and Graphics* **3** (1999) 177–183.

Multilevel Scattered Data Approximation by Adaptive Domain Decomposition

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A new multilevel approximation scheme for scattered data is proposed. The scheme relies on an adaptive domain decomposition strategy using quadtree techniques (and their higher-dimensional generalizations). It is shown in the numerical examples that the new method achieves an improvement on the approximation quality of previous well-established multilevel interpolation schemes.

An Investigation into Novel Approximation Estimators

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Abstract

Consider approximating a set of discretely defined values $f_1, \ldots, f_n$ say, with a chosen approximating form F. If we want the approximation to be a good one, then we must carefully choose an appropriate estimator that will give a measure of, and ultimately minimise, the approximation error.

The estimator that we choose will depend on the underlying distribution of noise in the data. However, the task becomes difficult if there is more than one type of distribution present. We must also consider the level of noise in each of the distributions.

It is clear that when the data fall into this category, the use of traditional norms such as ℓ_1, ℓ_2 and ℓ_∞ are inappropriate. We need an estimator that will provide more versatility in our minimisation process.

In this paper, we introduce four novel estimators that have been investigated for their practical use in approximating data that contain a mixture of types and level of noise. The estimators that we present can all be written in the general form

$$\min \ E = \sum [G(\epsilon)]^2, \tag{1}$$

where ϵ is the usual residual $f - F$ and G is a function chosen to reflect the underlying noise distribution. We will show that by expressing these estimators in terms of simple Taylor series expansions or trigonometric identities, the approximation problem can be solved using iterative weighted least squares.

The effectiveness of the estimators in dealing with mixed noise distributions is demonstrated through some simple curve and surface fitting examples using radial basis functions.

Spline approximation of discontinuous parametric curves and surfaces with tangent conditions

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Abstract.

In CAGD, Geology and other Earth Sciences the problem of the construction of curves and surfaces which present some discontinuities from a set of points (Lagrange data) and other of tangent spaces -known as tangent conditions- is frequently encountered.

We introduce the notion of the discrete smoothing variational spline in [2] by minimizing a quadratic functional in a finite-dimensional space of finite elements. The authors in [3] present a smoothing method for fitting parametric surfaces from sets of data points and tangent planes. In both cases the corresponding original curves or/and surfaces that are approximated do not present any discontinuities, so for its practice interest we decide in this work to introduce some discontinuities in order to study a discrete problem of approximation from a set of Lagrangian data and an other set of tangent conditions.

Namely, we study the following problem: given a differentiable function f in a subset Ω' of an open set $\Omega \subset \mathbb{R}^p$ with values in $\mathbb{R}^n$, $1 \leq p < n \leq 3$, whose first partial derivatives or she can present discontinuities in F with $\Omega' = \Omega \backslash \overline{F}$, construct a function σ that approximates f in the given points of Ω' and whose tangent spaces in the points of an other given set of Ω' are close to the tangent spaces of f on the same points.

To do this, firstly using the work of R. Arcangéli, R. Manzanilla and J. J. Torrens [1], we determine certain hypotheses about the set Ω' that allows to model the contingent discontinuities of f. Secondly, we study a smoothing method in a finite element space which results from adapting to this context the theory of the discrete smoothing variational splines (c.f. [2]). This method is justified by a convergence result under adequate hypotheses and an analysis of some numerical and graphical examples.

References

[1] R. Arcangéli, R. Manzanilla and J. J. Torrens, Approximation Spline de Surfaces de type explicite comportant des Failles, *Mathematical Modelling and Numerical Analysis* **31** n°5 (1997) 643–676.

[2] A. Kouibia and M. Pasadas, Approximation by Discrete Variational Splines, *J. of Comput. and Applied Math.* **116** (2000) 145–156.

[3] M. Pasadas, M.C. López de Silanes and J.J. Torrens, Approximation of Parametric Surfaces by Discrete Smoothing D^m–spline with Tangent Conditions, in: *Mathematical Methods in CAGD III*, M. Daehlen, T. Lyche and L. L. Schumaker (eds.) (1995) 403–412.

Markov and Jackson-type inequalities for multivariatepolynomials on curves

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The classical Markov and Jackson inequalities for univariate polynomials provide bounds for the derivatives of polynomials and the rate of best approximation, respectively. In this talk we shall present some recent results which extend the above inequalities for multivariate polynomials considered on plane or space curves.
An interesting feature of these results is the influence of the analytic properties of the curves on corresponding estimates.

On Adaptive Wavelet Methods

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I would like to discuss two different applications where the particular features of wavelet bases, the Riesz basis property together with their locality, are exploited.

The first example concerns **explicitly** given information and discusses the problem of fitting nonuniformly distributed data to approximate surfaces.

The second application, in which the information is contained **implicitly**, is concerned with an optimal control problem with constraints appearing in form of a linear elliptic partial differential equation. Both applications have in common that the formulation of the solution method is based on minimizing a quadratic functional and that the concept of adaptivity in a coarse--to--fine fashion combined with thresholding plays a central role.

A segmentation process under interpolation conditions using a Level Set approach applied to Deformable Models discretized on a Finite Element basis.

by Carole Le Guyader^, Dominique. Apprato*, & Christian Gout^.

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A priori knowledge of interpolation conditions (Lagrange data points, curves etc...) leads to some geometric constraints on the model under study. To avoid the parameterization of the structure, we propose a "level set" approach on deformable models. The solution is obtained by the minimization of a non linear PDE under interpolation conditions. Numerical examples will be given.

Where There's a Will There's a way
The Life and Work of Will Light.

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Will Light made a number of important contributions to approximation theory; for the early part of his career in the computation of norms of projections on continuous functions, the analysis of the Diliberto-Straus algorithm for approximating a bivariate function by the sum of univariate functions, and in the existence of best approximations in various functions spaces. Ward Cheney is a central figure in this part of Will's career. In the 1990s Will moved into multivariate approximation, in quasi interpolation and interpolation using radial and ridge functions. He was interested in applications in neural network approximation. With Ward he showed ghow to do quasi interpolation with non compactly supported functions. His relationship with Rick Beatson became influencial in the direction of his work here. Together they made significant impacts in quasi interpolation in the absence of polynomial reproduction and on compact domains, the fast evaluation of radial functions and the fast solution of the radial basis interpolation equations. Will was unusual in the field for extending technology in practical algorithmic issues, as well as theoretical issues. We will hopefully provide insight into the way Will worked and convey the love he felt for his subject.

Asymptotic expansion of multivariate Kantorovich type operators

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Abstract

Let us consider an interpolatory type linear operator, $L : C(D) \to C^{\infty}(D)$, $D \subseteq \mathbb{R}^m$, given by

$$Lf = \sum_{x \in H_L} f(x)\phi_x,$$

with $H_L \subseteq D$ finite and $\phi_x \in C^{\infty}(D)$ for all $x \in H_L$. A Kantorovich modification of L is obtained by taking the mean value of f in a neighborhood of x, U_x, in place of $f(x)$ for every $x \in H_L$. That is to say,

$$\tilde{L}f = \sum_{x \in H_L} \frac{1}{\mu(U_x)} \left(\int_{U_x} f \right) \phi_x.$$

On the other hand, given a sequence of linear operators $\{L_n : C(D) \to C^{\infty}(D)\}_{n \in \mathbb{N}}$, an asymptotic expansion of order r for the sequence is an expression of the type

$$L_n f(x) = \sum_{i=0}^{r} a_i(x) n^{-i} + o(n^{-r}), \quad x \in D.$$

In this work we study several classical sequences of Kantorovich type operators both in univariate and multivariate case. We obtain the asymptotic expansion for them and their partial derivatives with explicit computation of the coefficient functions a_i.

Multivariable Analysis Applied to Movement Control of a Four Degrees of Freedom Pick and Drop Robot

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This article discusses the implementation of multivariable analysis to movement control of a robot considering four degrees of freedom. A computer model is presented that includes options to control robot movement using the computer mouse. Further, an option to perform an automatic controlled movement to a specific position is discussed.

The scenario is one where a robot, four degree of freedom, is used to pick a part from one surface, work center 1 (WKC1), and move it to another surface, work center 2 (WKC2). The task is repeated for a given number of times based on a predefined number of parts due to arrive at WKC1. At WKC1 and WKC2 each part receives some kind of processing.

The task that the robot must perform can be described as follows: When a part arrives at WKC1, it stays there for a certain time, in the range of 4 to 10 units of time. This is to simulate that the part is receiving processing at WKC1 or that WKC1 is performing an operation on the part. When the operating time at WKC1 is completed, the part is then ready to be transfer to WKC2. So, a signal is triggered to request the robot to perform the transfer. The transfer of a part from WKC1 to WKC2 is performed if WKC2 is free.

At WKC2 a part also stays there for a given time, in the range of 4 to 10 units of time. In both work centers, a random number is generated in the mentioned range. A uniform distribution is considered when generating the times to simulate processing time on both work centers. Due to the consideration of random variables on WKC1 and WKC2, it could happen that WKC2 is free but WKC1 is busy or vice versa. In such a case, the robot performs the transference only when WKC1 has finished its operation and there is no part at WKC2.

When the robot is not transferring parts it waits at a predefined home position where it remains until another part needs to be transferred from WKC1 to WKC2.The parts arrive at WKC1 in a similar range, from 4 to 10 units of time. When a part, at WKC2, completes its operation it is moved out to a storage buffer but this movement is not considered in the model.

The model was implemented in a PC computer using Visual C++ and OpenGL. The program shows a 3D model of the scenario described above. The result of 30 runs of the simulation is included where 100 components are transferred from WKC1 to WKC2 on each run.

Quaternion Splines

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The goal of this work is to reconstruct movements from wich several data are known (coming from different observation points and different times)

To do that we first introduce the general notion of quaternion splines anf we explain our choose of dual quaternion B-Splines for our particular purpose.

Divergence-free Radial Basis Functions Applied to a Navier-Stokes Equation

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Keywords :Approximation, divergence-free, radial basis functions, incompressible Navier-Stokes equation.

Approximation and interpolation employing radial basis functions (RBFs) has found important applications in areas like signal processing, medical imaging, and neural networks since the early 1980's.
Some applications require that certain physical properties are satisfied by the interpolant, for example being divergence free in case of incompressible data. This gives reason for the recent construction of divergence-free matrix-valued RBFs by Narcowich and Ward [1]. These functions are smooth and have unbounded support. That makes the inversion of the resulting interpolation matrices rather expensive. We introduce a new class of matrix-valued RBFs that are divergence free as well as compactly supported and are generated by certain scalar-valued RBFs [2]. Since the resulting interpolation matrices are symmetric, positive definite, and sparse, fast solvers can be applied to invert these matrices. We proceed by discussing error estimates and stability results for a wide class of generalized Hermite interpolation problems. We conclude by using these functions in PDEs arising from an incompressible fluid dynamics applications.

1. Narcowich, F. J. and J. D. Ward, Generalized Hermite interpolation via matrix-valued conditionally positive definite functions, in Mathematics of Computation 63 (1994), 661--687.

2. Wendland H., Piecewise polynomial, positive definite and compactly supported radial functions of minimal degree, in Advances in Computational Mathematics 4 (1995), 389-396.

Filling holes with Radial Basis Functions

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Surface reconstruction from large unorganized data sets is very challenging especially if the data present undesired holes. This is usually the case when the data come from laser scanner 3D acquisitions or if they represent damaged objects to be restored. An attractive research direction is focused on situations in which these holes are too geometrically and topologically complex to fill using triangulation algorithms.

In this work a local approach to surface reconstruction from point-clouds based on Radial Basis Functions (RBF) is presented that progressively fills the holes expanding the neighbouring information. The method is based on the algorithm introduced in [1] which has been successfully tested for the smooth multivariate interpolation of large scattered data sets. The local nature of the algorithm allows for real time handling of large amount of data, since the computation is limited to suitable small areas, thus avoiding the critical efficiency problem involved in RBF multivariate interpolation. Several tests on simulated and real data sets demonstrate the efficiency and the quality of the reconstructions obtained using the proposed algorithm.

[1] Lazzaro, D., Montefusco, L.B.,
Radial basis functions for the multivariate interpolation of large scattered data sets.
Journal of Computational and Applied Mathematics 140}, 2002, pp. 521--536.

On a certain class of multivariate operators

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In this paper we define and study a new multivariate positive linear operator that generalizes some classical ones. We demonstrate some of their properties and examine a simple particular case.

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Error Estimates for Scattered-Data Interpolation via entering

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Error estimates for scattered data interpolation by «shifts» of a positive definite function for target functions in the associated reproducing kernel Hilbert space (RKHS) have been known for a long time. However, apart from special cases where data is gridded, these estimates do not apply when the target functions generating the data are outside of the associated RKHS, and in fact until very recently no estimates were known in such situations. J. D. Ward and myself first engineered an «escape» from the RKHS in the case of the sphere, where we obtained error estimates for interpolating functions $f \in C^{k2}(S^n)$ from «shifts» of a smoother positive definite function Ψ defined on S^n. Quite recently, we have obtained similar Sobolev-type error estimates on compact regions of R^n when the RBFs have Fourier transforms that decay algebraically. In addition, we showed that it is possible to construct band-limited interpolants that are also near-best approximants to such functions, with the band size being inversely proportional to the minimal separation of the data sites. In this talk, we will discuss these results and mention applications to discrete and continuous least-squares.

Wavelet based Solution to Time-Dependent Two Point Initial Boundary Value Problems with Non-Periodic Boundary Conditions involving High Intensity Heat and Mass Transfer in Capillary Porous Bodies.

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The Wavelet solution for boundary-value problems is relatively new and has been mainly restricted to the solutions in data compression, image processing and recently to the solution of differential equations with periodic boundary conditions. This paper is concerned with the wavelet-based Galerkin's solution to time dependent two-point initial-boundary-value problems in high-intensity drying of a moist porous body with non-periodic boundary conditions. The wavelet method can offer several advantages in solving the initial-boundary-value problems than the traditional methods such as Fourier series, Finite Differences and Finite Elements by reducing the computational time near singularities because of its multi-resolution character. We have recently shown it's applicability to linear two point initial boundary value problems involving singular phenomena. In sequel to our previous works [10, 11], this paper extends the wavelet technique applicability to coupled phenomena with non-periodic boundary conditions. Here, we apply Galerkin's approach to the high-intensity problem involving coupled equations of molar-molecular heat and mass transfer in the capillary-porous body. The results of the wavelet solutions are examined and compared with those of low-intensity drying problem. This paper on the whole indicates that the wavelet technique is a strong contender for an approximate solution to two point initial boundary value problems in heat and mass transfer in capillary porous bodies with non-periodic conditions.

Adaptive Surface Fitting to Point Cloud Data

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We describe techniques for computing a triangular mesh surface approximation to a point cloud of unorganized 3D data points. The general strategy is a top-down, adaptive approach that allows for the complexity of the approximating surface to conform to the complexity of the data. We discuss the two main aspects of the algorithm consisting of the refinement strategy and the surface fitting criteria. Triangles that are selected for refinement based upon a global error distribution are subdivided so as to optimize triangle shape properties while allowing overall quality fitting surfaces. Selecting vertex positions for optimal fitting surfaces is based upon a new, unique method of measuring the error between surfaces and unorganized point clouds which itself is based upon certain volume models. We illustrate the method with several examples and show comparisons to other algorithms.

Lemniscates 3D: A CAGD Primitive?

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A 3D lemniscate is an implicitly given surface which generalizes the well known Bernoulli lemniscates curves and the Cassini ovals. The surface is characterized by placing a finite number of points in space (the foci) and choosing a constant (radius). The algebraic degree of the surface is twice the number of foci. The surface is always contained in the union of certain spheres centered at the foci. The distribution of the foci in 3D gives a rough idea of the 3D shapes that could be modelled (or approximated) as one varies the the radius. The radius itself controls the evolution of a family of lemniscates with a fixed set of foci. The position of the foci can be used to stretch and to produce knoblike features.
Given a placement of the foci, for a small radius the surface consists of a number of spherelike surfaces centered at the foci which do not touch each other. As the radius increases the disconnected pieces coalesce producing interesting surfaces.

In order to make 3D lemniscates a potentially useful primitive for CAGD it is necessary to control the coalescing/splitting of the connected components of the lemniscate while we move the foci and change the radius, simultaneously.
In this talk we will show examples of lemniscate deformation avoiding splitting and coalescing using singular poits and singular values.

Construction of surfaces by smoothing PDE splines

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Abstract

In this work we present a design method for free–form surfaces from a set of approximation points and a boundary value problem for a partial differential equation (PDE).

Namely, suppose given a nonempty bounded sufficiently regular subset Ω of $\mathbb{R}^2$, $m \in \mathbb{N}$, $m > 1$, and a linear differential operator $L : H^{2m}(\Omega) \to L^2(\Omega)$ defined by

$$Lu = \sum_{|\mathbf{i}|,|\mathbf{j}| \leq m} (-1)^{|\mathbf{j}|} \partial^{\mathbf{j}} (p_{\mathbf{ij}} \partial^{\mathbf{i}} u)$$

with $\mathbf{i}, \mathbf{j} \in \mathbb{N}^2$, $|\mathbf{i}| = i_1 + i_2$, for any $\mathbf{i} = (i_1, i_2) \in \mathbb{N}^2$ and $p_{\mathbf{ij}} \in H^m(\Omega)$, for any $|\mathbf{i}|, |\mathbf{j}| \leq m$. Moreover, we suppose that it verifies the following property:

$$\exists\, C > 0, \sum_{|\mathbf{i}|,|\mathbf{j}| \leq m} \mathbf{p_{ij}} \mathbf{x}^{\mathbf{i}} \mathbf{x}^{\mathbf{j}} \geq C \sum_{\mathbf{i} \leq m} |\mathbf{x}^{\mathbf{i}}|^2, \ \forall \mathbf{x} \in \Omega.$$

Let $N_1 \in \mathbb{N}$, $A = \{\mathbf{a}_i,\, i = 1, \ldots, N_1\} \subset \Omega$ and $\beta_i \in \mathbb{R}$, for all $i = 1, \ldots, N_1$.

Consider the boundary value problem given by

$$\left| \begin{array}{l} Lu = f \ \text{ in } \ \Omega, \\ \dfrac{\partial^j}{\partial \mathbf{n}^j} = h_j \ \text{ in } \ \partial\Omega, \ \forall\, j \leq m-1, \end{array} \right. \tag{1}$$

where $f \in L^2(\Omega)$ and $h_j \in L^2(\Omega)$, $j = 0, \ldots, m-1$, are given.

Let $H = \{u \in H^m(\Omega) : \left.\dfrac{\partial^j u}{\partial \mathbf{n}^j}\right|_{\partial\Omega} = h_j,\ j \leq m-1\}$ and $\varepsilon > 0$.

Under these conditions, we define the *smoothing PDE spline* associated to A, B, ε and Problem (1) as the unique solution of the following minimization problem: Find $\sigma \in H$ such that $J(\sigma) \leq J(v)$, for all $v \in H$, where J is the functional defined in $H^m(\Omega)$ by

$$J(v) = \sum_{i=1}^{N_1} \langle v(\mathbf{a}_i) - \beta_i \rangle^2 + \varepsilon \left(\sum_{|\mathbf{i}|,|\mathbf{j}| \leq m} \int_\Omega p_{\mathbf{ij}}(\mathbf{x}) \partial^{\mathbf{i}} u(\mathbf{x}) \partial^{\mathbf{j}} u(\mathbf{x}) d\mathbf{x} - 2 \int_\Omega f(\mathbf{x}) v(\mathbf{x}) d\mathbf{x} \right).$$

The first term in J measures how well v approaches the data β_i, for any $i = 1, \ldots, N_1$, in the least squares sense. The second term indicates how well v approximates the solution of Problem (1), which is weighted by the ε parameter.

We discretize this problem in a finite–dimensional subspace of type finite elements or box–splines functions to obtain the *discrete smoothing PDE spline* and we prove some convergence results. Finally, we analyze some numerical and graphical examples in order to show the validity and effectiveness of our method.

Some recent results on a class of bivariate refinable functions

by Costanza Conti, Laura Gori, *Francesca Pitolli
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The main goal of this paper concerns the construction of some classes of bivariate refinable functions generated by means of a method based on thedirectional convolution product.

In this construction are involved certain monovariate refinable functions introduced in [1].

[1] L. Gori, F. Pitolli: *A class of totally positive refinable functions*, Rend. Mat. Serie VII, 20 (2000) 305-322

Interpolation and Approximation by using locally tensorial product splines

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Approximation by using tensorial product functions presents the following main drawback : when we need concentrating data points in a region of the plane, we need add many points alined in the x direction and in the y direction, in order to keep the tensorial product aspect of the data ; these added points are of no utility in the approximation process and increase in an unduty way the size of the problem to be solved.

In order to avoid this drawback, still using the advantage of tensorial product functions, the idea is the following one : we express the approximating function as a linear combination of tensorial product B-splines, each B-spline being with equidistant knots, but in the region of the plan where we need more points, the steps of the B-splines are smaller, and so there is more B-splines. The so-obtained function is so a linear combination of tensorial product basis functions, is locally a tensorial product spline (since a product of univariate polynomials in rectangular patches), but is not a tensorial product function. In more mathematical means, the approximating function is written $\sigma(x)=\sum_i \lambda_i B_i(x)$ where the various B_i functions are tensorial product *B-spl*ines with equidistant knots, but all B_i have not the same length of steps.

This suppose that the B_i functions (more precisely their position and the length of their step) are chosen in an appropriate way, which will be discussed in detail.

Multi-sided Macro-Element Spaces Based on Clough-Tocher Triangle Splits

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Keywords: multivariate splines, triangulations.

We consider a set Ω (not necessarily connected) whose boundary curves are polygonal and *H* a polygon which shares some of its boundary edges with Ω. Let Δ be a regular triangulation of the set Ω.

A triangulation Δ_H of *H* and a spline space $S_H \subset S_d^{r,\rho}(\Delta_H)$ are created, such that every spline s $\in S_d^{r,\rho}(\Delta)$ can be extended onto the space $S_d^{r,\rho}(\widetilde{\Delta})$ where $\widetilde{\Delta} = \Delta \cup \Delta_H$.

The conversion matrix between non-uniform B-spline and Bézier representation

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In order to simplify a lot of geometric operations on B-spline curves, it is useful to possess a conversion formula that allows to represent each non-vanishing B-spline segment as a B\'ezier curve. Althought in the univariate case this can be done elegantly by knot-insertion [1], in the multivariate case this approach results much more complex. For this reason, in order to convert three- and four-directional Box-splines into B\'{e}zier patches, in [2] and [3] was proposed an alternative method,
which extends a computational scheme proposed for the uniform univariate case. This computational scheme was reformulated in [4] to express the direct transformation in matrix notation and to carry out the inverse conversion algorithm which directly transforms each B\'ezier segment into the uniform B-spline form.
In this work the previous proposal has been extended to the more general non-uniform case, generating the matrix conversion formulae which respectively enable us to convert each non-uniform B-spline curve segment into B\'ezier form and viceversa. While arbitrary knot configurations make the classical procedures tedious and sophisticated, the computation via the non-uniform conversion matrices turns out to be very easy and efficient: in fact just exploiting the numerical form of the integral relation between polynomial and spline basis functions (which involves the shift, subctract and integration operators over the spline knot-partition) we can generate recursively the two conversion matrices. In the multivariate case the computation of the conversion matrices turns out to be very efficient due to their particular structure, and the transformation algorithms result very simple.
In particular in the biquadratic and bicubic bivariate tensor-product case, the B-spline/Bézier conversion matrix can be regarded as the limit of the non-uniform subdivision matrix of Doo-Sabin and Catmull-Clark schemes [5] respectively.}

1. Boehm W., Generating the B\'ezier points of B-spline curves,{\sl Computer Aided Design} {\bf 13}, (1981), 365--366.
2. Chui C.K., Lai M.J., Computation of Box splines and B-splines on triangulations of nonuniform rectangular partitions, {\sl Approximation Theory \& its Applications} No.{\bf 3:4}, (Dec. 1987), 37--62.
3. Chui C.K., Lai M.J., Algorithms for generating B-nets and graphically displaying spline surfaces on three- and four-directional meshes, {\sl Computer Aided Geometric Design} {\bf 8} (1991), 479--493.
4. Romani L., Sabin M.,The conversion matrix between uniform B-spline and B\'ezier representation, {\sl submitted }, (2003).
5. Sederberg T.W., Sewell D., Sabin M.,Non-uniform Recursive Subdivision Surfaces, {\sl Computer Graphics Proceedings, Annual Conference Series} (1998)

Integration of Statistic and Harmonic Analysis to Predict Water Levels in the Estuaries and Shallow Waters of the Gulf of Mexico.

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The goal of our on-going research is to develop effective and reliable tools for predicting water levels in the shallow waters of the Gulf of Mexico. There are different methodologies for the prediction of water levels including statistical models, harmonic analysis, numerical methods based on finite elements/finite differences, neural networks, etc. We have discussed a statistically based model of prediction (SMP) of tides and compared it with neural network predictions (NNP). Both of these approaches are under development at the Conrad Blucher Institute in cooperation with the Department of Computing and Mathematical Sciences both of Texas A&M University-Corpus Christi (A&M-CC). Many stations of the Texas Coastal Ocean Observation Network (TCOON) located in the coastal waters of the Gulf of Mexico provide data for such predictions. Tide charts are mostly based on astronomical forcing or the influence on water levels of the respective motions of the earth, the moon, and the sun. There are locations around the world, including the Gulf of Mexico, where other factors such as meteorological forcing often dominate tidal forcing and limit significantly the application of tide charts. In such cases other models must be developed to forecast water levels.

Using real time data provided by 50 stations of TCOON, we applied methods of main components of factor analysis. It was shown that 45% to 75% of variations of water levels in estuaries and shallow waters are explained by factor "weather", at the same time other four main components are periodical. In the deep waters situation is reversed: the first three of four main components are periodical and the last one is so-called "weather" component. The general idea is to predict water levels for two hours by using a multi-regression model. Then step by step - using these predicted levels as the given levels - predict water level for 4,6,..,48 hours. We now believe that information about weather (pressure, wind, temperature, etc.) is hidden in the previous levels of water. By applying multiple regression and factor analysis to different kinds of data (water level, wind speed and direction, water temperature) we were able to make quite reliable predictions from 6 to 72 hours. Results of this investigation were compared with predictions based on the usage of other methodologies. Integration of harmonic and statistic approaches in one model has made possible highly reliable predictions for estuaries and shallow waters. This model worked remarkably well: R-squared for all stations at least 0.95. To make further predictions we used the previously determined levels of water. Such a step by step approach produced quite good predictions. The table below is an example of statistical data for differences between predicted and real levels of water for 6, 12, 18, 24, 30, 36, 42, and 48 hours:

Table. Statistical characteristics of prediction errors (in meters)

	Mean	Median	Std. Deviation	Min. range	Max. range
Error 6hr	0.0124	0.0121	0.310	-0.858	0.796
Error 12hr	0.0129	0.0117	0.105	-0.421	0.442
Error 18hr	0.0155	0.0108	0.313	-0.951	0.866
Error 24hr	0.00924	0.0023	0.177	-0.580	0.622
Error 30hr	0.0176	0.0062	T0.297	-0.748	0.803
Error 36hr	0.0140	0.0198	0.184	-0.653	0.641
Error 42hr	0.0156	- 0.0034	0.293	-0.746	0.828
Error 48hr	0.0265	0.0289	0.193	-0.568	0.593

Multivariate Interpolation by Polynomials as Limits of Radial Basis Functions

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In many cases, multivariate interpolation by smooth radial basis functions converges towards polynomial interpolants, when the basis functions are scaled to become «wide». The talk provides sufficient criteria for this convergence phenomenon to occur, and the structure of the polynomial limit interpolation is investigated to some extent. It turns out that a variety of new well--posed multivariate polynomial interpolation processes can be formulated this way, leading to interesting questions about their relationships. Part of them can be proven to be «least» in the sense of de Boor and Ron. A special case is the de Boor/Ron multivariate polynomial interpolation method, and it is shown that it occurs as the limit of interpolation by Gaussian radial basis functions when the scaling gets «wide». As a byproduct of the convergence analysis, a stable method for preconditioning the matrices arising with interpolation by smooth radial basis functions is developed.

C^1 quintic splines on type-4 tetrahedral partitions

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Keywords: trivariate splines, interpolation

Starting with a partition of a rectangular box into subboxes, we show how to construct a natural tetrahedral (type-4) partition and associated trivariate C^1 quintic polynomial spline spaces with a variety of useful properties, including stable local bases and full approximation power. We also show how the spaces can be used to solve certain Hermite and Lagrange interpolation problems.

One-Dimensional One-Way Cellular Automata, Encoding and Polynomial Interval Maps

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Computation with cellular automata identifies data (as represented by real numbers on the unit interval) and computation steps with configurations and time evolution on cellular automata spaces, respectively. Furthermore, halting states can be identified with attractors of dynamical systems evolving in cellular spaces.

It is well known that cellular automata evolutions can be related to functions of the unit interval by using proper encoding and decoding relationships. A natural question arises in connection with the minimum requirements that these automata, along with their respective encoding and decoding relations, should fulfill when the computed functions are well behaved— as represented by polynomials.

The structure of a class of one-dimensional one-way infinite cellular automata and their corresponding encoding and decoding relations— which approximate polynomials to any degree of accuracy at the expense of increasing the number of states or the neighborhood size— are studied by following a constructive method and the general idea of partitioned cellular automata.

It is shown that dynamical properties of the automata, such as the existence of an uncountable set of attractors and an uncountable set of Garden of Eden configurations, play an important role in the accomplishment of the task. Furthermore, it is proved that the encoding have a neural-like network structure that suggests that the field of neural networks can be a useful tool in the study of the relationship between cellular automata and interval maps.

It is proved that for this particular case of cellular automata, the neural network structure is given in general by a Sigma-Pi architecture. Furthermore, the weights of such a network can be defined in terms of rational numbers containing information of the coefficients defining the computed polynomials. In this sense, the combined systems given by cellular automata plus neural network are a complete one.

Keywords— One-Way Cellular Automata, Encoding / Decoding, Polynomials, Attractors, Garden of Eden, Neural Network, Signal Function.

Web-Based Water Level Predictions Along the Texas Coast Using Multivariate Statistical Modeling and Harmonic Analysis

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Water level forecasts are essential to the success of trade and industry in the Gulf of Mexico, but present forecasting methodologies do not provide accurate predictions for the Gulf Coast region. Tide charts produced by harmonic analysis are the existing standard, but these charts only show the astronomical forces acting upon the water. While this proves to be an accurate predictor for most of the Atlantic and Pacific Coasts, water level changes along the Texas Coast are strongly effected by meteorological factors and thus require a modified prediction model, rather than harmonic analysis alone. A web-based tool was created that fuses harmonic analysis with multivariate statistical modeling to predict water levels along the Texas Gulf Coast. The result is a drastic improvement on the current model with forecasts available via the web. Water level data used to make these predictions is made available by the Texas Coastal Ocean Observation Network (TCOON). TCOON collects meteorological data from over 50 stations along the Gulf Coast, from Mexico to Louisiana. Water level predictions, as well as skill assessment statistics, are dynamically generated based on a set of user given criteria including station identifier, dates, number of coefficients, and prediction range. Since harmonic analysis already provides fairly accurate predictions for the astronomical forces that impact water level, linear regression is used to predict the differences between the actual and harmonic water levels. These differences are added to harmonic water levels resulting in greatly improved water level forecasts.

Quaternionic approximation a tool for PDE solving

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We present several examples of a method devoted to present a physical problem in terms of quaternionic functions and in that way avoid to solve the correspondent PDE of the problem and instead approximate a set of quaternionic functions or data by means of a quaternionic approximating function. The main example is Navier Stokes equations

Combining K-Means and Semivariogram-Based Grid Clustering

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There exist huge amounts of spatial data that may be obtained from satellite images, medial equipment, Geographical Information System (GIS), image database, etc. Grid-based clustering algorithms have been proposed for spatial data. Their main characteristic is that the algorithms quantize the space into a finite number of bins such that bins are constrained to regular blocks while the real spatial distribution of the object is not regular. Clustering may help to automate the process of analysis and understanding of spatial data. It is used to identify and extract interesting characteristics and patterns in the underlying data. The fundamental clustering problem is partition a given data set into groups such that the data in the cluster are similar to each other.

K-Means clustering proposed by Forgy [6] in 1965 is one of the most popular methods. This method is non-hierarchical and searches the best set of k clusters centroids, which determines the structure of the partition by assigning each element to its nearest centroid. Its goal is to minimize the distance in the elements within each cluster while maximizing this value between elements in different clusters. The problems involved in the K-Means algorithm are its high sensitivity to initial starting conditions and that it requires of the speciation of k, the final number of clusters. There have been several proposals to address these problems: Bradley and Fayyad [1] proposed a technique based on the estimation of the nodes of the joint probability density of the data and placing a cluster centroid at each node. Huang [8] proposed an extension to the K-Means to use with categorical values. A few methods for clustering with spatial data have been proposed. Ester, Sander, Kriegel and Xu [5] presented a density-based clustering algorithm that discovers cluster with arbitrary shape. Schikuta [12] proposed a hierarchical grid clustering algorithm by using a density index to comparer and evaluate the possible pattern cells to find cluster centers and combine neighbour cells.

In this paper we proposed a new method whereby we combine the efficiency of the K-Means technique with semivariogram-based grid clustering to deal with these problems. It is based on the assumption that the data have spatial distribution and their location is known. Since the spatial distribution of the data is known this information can be used to determine correlated set. Uniform grids are estimated using the range parameter of the semivariogram to define a set of clustering. This partition is used as initial condition in the K-Means algorithm.