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RECENT ADVANCES IN APPLIED MATHEMATICS AND COMPUTATIONAL AND INFORMATION SCIENCES

Volume II

Proceedings of the 15th AMERICAN CONFERENCE ON APPLIED MATHEMATICS
and Proceedings of the INTERNATIONAL CONFERENCE ON COMPUTATIONAL AND INFORMATION SCIENCE 2009

Houston, USA, April 30-May 2, 2009

Sponsored, Organized and Hosted by the UNIVERSITY of HOUSTON - DOWNTOWN
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Preface

This year the 15th American Conference on Applied Mathematics and the International Conference on Computational and Information Science were held in Houston, USA. The Conference remains faithful to its original idea of providing a platform to discuss theoretical and applicative aspects of linear algebra, numerical analysis, differential equations, algorithms, discrete mathematics, systems, communications, control, algorithms and theory of computation, artificial intelligence, automata and formal language theory, computer networking, computer science education etc. with participants from all over the world, both from academia and from industry.

Its success is reflected in the papers received, with participants coming from several countries, allowing a real multinational multicultural exchange of experiences and ideas.

The accepted papers of this conference are published in this Book that will be indexed by ISI. Please, check it: www.worldses.org/indexes as well as in the CD-ROM Proceedings. They will be also available in the E-Library of the WSEAS. The best papers will be also promoted in many Journals for further evaluation.

A Conference such as this can only succeed as a team effort, so the Editors want to thank the International Scientific Committee and the Reviewers for their excellent work in reviewing the papers as well as their invaluable input and advice.

The Editors

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Keynote Lecture 1

Four Open Mathematical Problems Related to Computer Graphics and Geometric Modeling

Professor Ron Goldman
Department of Computer Science
Rice University

Abstract: Four unsolved problems that originate from research in Computer Graphics and Geometric Modeling will be presented. The first problem involves understanding the notion oscillation for Bezier surfaces, the freeform polynomial surfaces most common in Computer Graphics and Geometric Modeling. The second problem concerns gnerating smooth (C2) surfaces via subdivision from triangular or quadrilateral meshes of arbitrary topology. The third problem is related to Bezier curves and univariate Bernstein polynomials, and concerns the combinatorics of symmetrizing multiaffine functions. The fourth and final problem pertains to fractals and asks if there is an algorithm to determine whether two arbitrary sets of contractive affine transformations generate the same fractal.

Brief Biography of the Speaker: Ron Goldman is a Professor of Computer Science at Rice University in Houston, Texas. Professor Goldman received his B.S. in Mathematics from the Massachusetts Institute of Technology in 1968 and his M.A. and Ph.D. in Mathematics from Johns Hopkins University in 1973. He is an associate editor of Computer Aided Geometric Design. In 2002, he published a book on Pyramid Algorithms: A Dynamic Programming Approach to Curves and Surfaces for Geometric Modeling. Dr. Goldman's current research interests lie in the mathematical representation, manipulation, and analysis of shape using computers. His work includes research in computer aided geometric design, solid modeling, computer graphics, and splines. He is particularly interested in algorithms for polynomial and piecewise polynomial curves and surfaces, and he is currently investigating applications of algebraic and differential geometry to geometric modeling. He has published over a hundred articles in journals, books, and conference proceedings on these and related topics. Before returning to academia, Dr. Goldman worked for ten years in industry solving problems in computer graphics, geometric modeling, and computer aided design. He served as a Mathematician at Manufacturing Data Systems Inc., where he helped to implement one of the first industrial solid modeling systems. Later he worked as a Senior Design Engineer at Ford Motor Company, enhancing the capabilities of their corporate graphics and computer aided design software. From Ford he moved on to Control Data Corporation, where he was a Principal Consultant for the development group devoted to computer aided design and manufacture. His responsibilities included data base design, algorithms, education, acquisitions, and research. Dr. Goldman left Control Data Corporation in 1987 to become an Associate Professor of Computer Science at the University of Waterloo in Ontario, Canada. He joined the faculty at Rice University in Houston, Texas as a Professor of Computer Science in July 1990.

Keynote Lecture 2

Cardiovascular Informatics: How to Stop a Heart Attack Before it Happens

Professor Ioannis A. Kakadiaris
Computational Biomedicine Lab Depts. of CS, ECE
Biomedical Engineering, University of Houston

Abstract: In this talk, first I will offer a short overview of the research activities of the Computational Biomedicine Laboratory, University of Houston. Then, I will present our research in the area of biomedical image computing for the mining of information from cardiovascular imaging data for the detection of persons with a high likelihood of developing a heart attack in the near future (vulnerable patients). Specifically, I'll present methods for detection and segmentation of anatomical structures, and shape and motion estimation of dynamic organs. The left ventricle in non-invasive cardiac MRI data is extracted using a novel multi-class, multi-feature fuzzy connectedness method and deformable models for shape and volume estimation. In non-invasive cardiac CT data, the thoracic fat is detected using a relaxed version of multi-class, multi-feature fuzzy connectedness method. Additionally, the calcified lesions in the coronary arteries are also identified and quantified using a novel hierarchical supervised learning framework from the CT data. In non-invasive contrast-enhanced CT, the coronary arteries are detected using our novel tubular shape detection method for motion estimation and possibly, for non-calcified lesion detection. In invasive IVUS imaging, our team has developed a unique IVUS acquisition protocol and novel signal/image analysis methods) for the detection (for the first time in?vivo) of 'vasa vasorum' (VV). The VV are micro-vessels that are commonly present to feed the walls of larger vessels; however, recent clinical evidence has uncovered their tendency to proliferate around areas of inflammation, including the inflammation associated with vulnerable plaques. In summary, our work is focused on developing novel computational tools to mine quantitative parameters from the imaging data for early detection of asymptomatic cardiovascular patient. The expected impact of our work stems from the fact that sudden heart attack remains the number one cause of death in the US, and unpredicted heart attacks account for the majority of the $280 billion burden of cardiovascular diseases.

Brief Biography of the Speaker: Prof. Ioannis A. Kakadiaris is an Eckhard Pfeiffer Professor of Computer Science, Electrical & Computer Engineering, and Biomedical Engineering at the University of Houston. He joined UH in August 1997 after a postdoctoral fellowship at the University of Pennsylvania. Ioannis earned his B.Sc. in physics at the University of Athens in Greece, his M.Sc. in computer science from Northeastern University and his Ph. D. at the University of Pennsylvania. He is the founder of the Computational Biomedicine Lab (www.cbl.uh.edu) and this year directs the Methodist-University of Houston-Weill Cornell Medical College Institute for Biomedical Imaging Sciences (IBIS) (ibis.uh.edu). His research interests include cardiovascular informatics, biomedical image analysis, biometrics, computer vision, and pattern recognition. Dr. Kakadiaris is the recipient of a number of awards, including the NSF Early Career Development Award, Schlumberger Technical Foundation Award, UH Computer Science Research Excellence Award, UH Enron Teaching Excellence Award, and the James Muller Vulnerable Plague Young Investigator Price. His research has been featured on Discovery Channel, National Public Radio, KPRC NBC News, KTRH ABC News, and KHOU CBS News.

Keynote Lecture 3

Compilation and Optimization for High Performance Computing

Professor Kleanthis Psarris
Department of Computer Science
The University of Texas at San Antonio
San Antonio, TX 78249
USA

Abstract: High end parallel and multi-core processors rely on compilers to perform the necessary optimizations and exploit concurrency in order to achieve higher performance. However, source code for high performance computers is extremely complex to analyze and optimize. In particular, program analysis techniques often do not take into account complex expressions during the data dependence analysis phase. Most data dependence tests are only able to analyze linear expressions, even though non-linear expressions occur very often in practice. Therefore, considerable amounts of potential parallelism remain unexploited. In this talk we propose new data dependence analysis techniques to handle such complex instances of the dependence problem and increase program parallelization. Our method is based on a set of polynomial time techniques that can prove or disprove dependences in source codes with non-linear and symbolic expressions, complex loop bounds, arrays with coupled subscripts, and if-statement constraints. In addition our algorithm can produce accurate and complete direction vector information, enabling the compiler to apply further transformations. To validate our method we performed an experimental evaluation and comparison against the I-Test, the Omega test and the Range test in the Perfect and SPEC benchmarks. The experimental results indicate that our dependence analysis tool is accurate, efficient and more effective in program parallelization than the other dependence tests. The improved parallelization results into higher speedups and better program execution performance in several benchmarks.

Brief Biography of the Speaker: Kleanthis Psarris is Professor and Chair of the Department of Computer Science at the University of Texas at San Antonio. His research interests are in the areas of Parallel and Distributed Systems, Compilers and Programming Languages. He received his B.S. degree in Mathematics from the National University of Athens, Greece in 1984. He received his M.S. degree in Computer Science in 1987, his M.Eng. degree in Electrical Engineering in 1989 and his Ph.D. degree in Computer Science in 1991, all from Stevens Institute of Technology in Hoboken, New Jersey. He has published extensively in top journals and conferences in the field and his research has been funded by the National Science Foundation and Department of Defense agencies. He is an Editor of the Parallel Computing journal. He has served on the Program Committees of several international conferences including the ACM International Conference on Supercomputing (ICS) in 1995, 2000, 2006 and 2008, the IEEE International Conference on High Performance Computing and Communications (HPCC) in 2008 and 2009, and the ACM Symposium on Applied Computing (SAC) in 2003, 2004, 2005 and 2006.

Keynote Lecture 4

If It's Fast It Must Be Newton's Method

Professor Richard Tapia
Computational & Applied Mathematics Department
Rice University
Houston, TX
USA

Abstract: Shifted inverse and Rayleigh quotient iteration are well-known algorithms for computing an eigenvector of a symmetric matrix. In this talk we demonstrate that each of these algorithms can be viewed as a standard form of Newton's method from the nonlinear programming literature. This provides an explanation for their good behavior despite the need to solve systems with nearly singular coefficient matrices. Our equivalence result also leads us naturally to a new proof that the convergence of the Rayleigh quotient iteration is q-cubic with rate constant at worst 1.

Brief Biography of the Speaker: Dr. Tapia is a mathematician and professor in the Department of Computational and Applied Mathematics at Rice University in Houston, Texas. He is internationally known for his research in the computational and mathematical sciences and is a national leader in education and outreach. His current Rice positions are University Professor, Maxfield Oshman Professor in Engineering, Associate Director of Graduate Studies, and Director of the Center for Excellence and Equity in Education. Among his many honors, he was the first Hispanic elected to the National Academy of Engineering. In 1996 President Clinton appointed him to the National Science Board. From 2001 to 2004 he chaired the National Research Council's Board on Higher Education and the Workforce. He has received the National Science Foundation's inaugural Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring; and the Lifetime Mentor Award from the American Association for the Advancement of Science. He was also named one of 20 most influential leaders in minority math education by the National Research Council. Currently, his NSF-supported programs, Alliances for Graduate Education in the Professoriate, and the Empowering Leadership Alliance have developed supportive communities of students and faculty members that ensure the success of underrepresented individuals in STEM fields at U.S. institutions of higher learning. Professor Tapia is recognized as a national leader in diversity and has delivered numerous invited addresses at national and international mathematics conferences, served on university diversity committees, and provided leadership at a national level.

Keynote Lecture 5

Geometric Analysis of SL(2,C) and Biologically-Mediated Computational Vision

Professor Jacek Turski
University of Houston-Downtown
Department of Computer and Mathematical Sciences
USA

Abstract: The group SL(2,C) of 2x2 complex matrices of determinant one occupies a truly remarkable place in mathematics and sciences. For example, it is inherently relevant to non-Euclidean geometries, modern complex analysis, and Einstein's special theory of relativity. In our work, SL(2,C) provides unified geometrical and numerical framework for computational vision, including visual neuroscience and machine vision systems.

The conformal camera, which models eyes imaging functions, produces image projective transformations generated by the linear-fractional mappings of the group SL(2,C). Thus, the camera's underlying geometry can be dually described as (1) one-dimensional complex projective geometry and (2) the conformal geometry imposed by the holomorphic complex structure of the Riemann sphere, also called Mobius, or inversive geometry. Although this geometry does not possess a distance, it provides a full set of descriptors for the Gestalt rules used in grouping fragmented contours into global shapes that primate visual system must solve when viewing natural images—one of the most difficult problems to model numerically. The unity of geometrical and numerical methods is established by the fact that the conformal camera has its own projective Fourier analysis, geometric Fourier analysis constructed on the group SL(2,C) in the framework of representation theory of semisimple Lie groups—a great achievement of the 20th century mathematics. Projective Fourier transform (PFT) provides image representation well adapted to both perspective transformations of retinal images and the retinotopy of the brain's visual and oculomotor pathways. Thus, PFT integrates the head, eyes, and visual cortex into one computational system. We use this binocular system to process visual information during fast scanning eye movements called saccades, employed to build up understanding of scenes despite the acuity limitations of foveate vision. We make about three saccades per second at the eyeball's maximum speed of 700 deg/sec. Visual sensitivity is markedly reduced, as we do not see moving retinal images. Despite these incisive eye movements, the fragmented pieces of visual information are integrated in the brain into a stable percept of the world. This visual constancy is maintained by neuronal receptive field shifts prior to saccade onset in various retinotopically organized cortical areas. These shifts give the brain access to visual information at the impending saccade target prior to the eyes' arrival. It integrates visual information across saccades and eliminates the need for starting visual information acquisition anew three times per second at each fixation. However this remapping is not perfect; around the time of saccades, the flashed probes are not perceived in veridical locations by humans in laboratory experiments, a phenomenon called perisaccadic mislocalization.

In our modeling of perisaccadic perception, we utilize basic properties of PFT. First, the PFT can be efficiently computed by a fast Fourier transform in logarithmic coordinates that approximate the retinotopy. Second, a simple translation in retinotopic (logarithmic) coordinates, modeled by the standard shift property of Fourier transform, remaps the presaccadic scene into a postsaccadic reference frame. This shift also accounts for the perisaccadic mislocalization.

This research program is guided by a strategy important in the contemporary neurocomputing research: linking known anatomical and physiological details with efficient computational modeling should be vital not only to emerging field of neural engineering but also to interpreting relevant neurophysiological data.

Brief Biography of the Speaker: Jacek Turski was awarded his Ph.D. from McGill University. After holding postdoctoral positions at the University of Manitoba and the University of Houston, he joined the University of Houston-Downtown where he is now a full professor in the Department of Computer and Mathematical Sciences. Five years ago Turski constructed projective Fourier analysis of the conformal camera in the framework of the representation theory of semisimple Lie groups. Based on this Fourier analysis, he is currently developing a physiologically realistic model of human and robotic vision systems. His research has been supported by the NSF grants. He was the recipient of the 2006 Scholarship/Creativity Award at UHD.

Plenary Lecture 1

Stability Analyses of a System of Nonlinear Partial Differential Equations and Applications

Professor Daniel N. Riahi
Professor Emeritus of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign,
Professor of Mathematics at the University of Texas-Pan American, USA
Department of Mathematics, 1201 West University Drive, University of Texas-Pan American, Edinburg, Texas78539-2999 U.S.A

Abstract: In this lecture we first review the stability analyses that have been carried out in the past for systems of nonlinear partial differential equations (PDEs) with important applications in fluid mechanics. Next, we consider a relevant nonlinear stability system of three-dimensional and time dependent nonlinear PDEs and their associated boundary conditions with applications for convective flows. Under certain assumptions, scaling and conditions, we will derive a mathematical model for the nonlinear stability system. We then determine some class of nonlinear steady and unsteady solutions of the resulting system. We explain the mathematical and nonlinear properties of these solutions. We also analyze the stability of these solutions and discuss the corresponding results for the stable solutions and their applications.

Brief Biography of the Speaker: Daniel N. Riahi joined Dept of Theoretical and Applied Mechanics (TAM) of The University of Illinois at Urbana-Champaign (UIUC) in 1980 and later affiliated with Dept of Mechanical and Industrial Eng (MIE) at UIUC. He served as Full Professor at UIUC from 1995 to 2005 and as Professor Emeritus at UIUC since 2005 with the Home Dept of Mechanical Science and Eng (MechSE) after joining MIE & TAM as a combined MechSE Dept at UIUC in 2006. Professor Riahi also was appointed as Full Professor in the Dept of Math at University of Texas-Pan American since 2006. Dr. Riahi was a Cambridge Univ. (U.K.)-Visiting Scholar in 1986. Earlier than 1980, Dr. Riahi worked at UCLA, Winthrop Univ. and a three-year Post-Doctoral position at the Florida State Univ. (FSU). His academic degrees are Ph.D. in Applied Math (Fluid Mech.) from FSU in1974, M.S. in Math from FSU in 1970 and B.S. in Math from Tehran Univ. in 1966.

Dr. Riahi's research work & interest in the last four decades include studies in convection, flow instabilities & turbulence, flow during solidification & crystal growth, applied partial differential equations, stability & asymptotic analyses, and math modeling and theoretical developments with applications to eng and physical sciences. His research accomplishments include new theories, such as those for flow in mushy layers, shear flow over wavy walls, rough turbulence and convective flow in the presence of imperfections, uncovering new types of flow patterns for simple- or mixed-modes and multi-modal cases, and a number of discoveries in fundamental areas of convective and shear flows, some of which were already confirmed by the experimental studies. These include, in particular, flow structure during alloy solidification, roughness roles in turbulent shear flow, flow patterns in layers with finite conducting boundaries and non-monotonic dependence of the heat flux with respect to the rotation rate. Professor Riahi received UIUC-MechSE &UIUC-TAM Service Appreciation Letters in 2006, a UIUC Service Recognition Certificate in 2006, a UIUC Honorific Title Award in 2005 and a UIUC-TAM Recognition Award in 2005. He was included in a UIUC List of Teachers Rank as Excellent by their Students. He is member of over seven professional societies and a Fellow of Wessex Institute of Great Britain. He is author of Chapters in a book on Centrifugal Processing that won the Best Basic Science Book-Award by International Academy of Aeronautics in 1997. Dr. Riahi also received a UIUC-COE Research Award in 1994 and an Outstanding UIUC Service Recognition Certificate in 1987. He is author of over 320 publications mostly published in rigorously refereed journals, including books, invited articles and chapters of books. Dr. Riahi's Professional Activities include Chairman of Applied Math at Winthrop Univ. (1977-78), and UIUC Eng Mech Coordinator and Chief Advisor (1985-86). He was awarded NSF Grants and supervised NASA Sponsored Res. Projects. He also received several UIUC-RB & UTPA-FRC Research Grants and NCSA Awards. He is ABI's Research Board Advisor, Member of the Program Committee of the 4th Int. Workshop on Materials Processing in High Gravity, Member of the Int. Scientific Committees of the 5th and 6th Int. Conferences on Advances in Fluid Mechanics and Member of Int. Scientific Advisory Board of Advances in Fluid Mech. He is Editor & Editorial Board Member of over 20 Technical Journals and Book Series.

Plenary Lecture 2

General Ray Method for Solution of Boundary Value Problems for Laplace Type Equations: Theoretical Foundation and Applications

Professor Alexander Grebennikov
Faculty of Physical and Mathematical Sciences
Autonomous University of Puebla
Av. San Claudio y Rio verde, Ciudad Universitaria, CP 72570, Puebla
MEXICO

Abstract: General Ray (GR) method for solution of the Dirichlet boundary value problems for the Laplace type equation with variable coefficient is proposed. The method is based on reduction of Partial Differential Equation (PDE) to assemblage of Ordinary Differential Equations (ODE) using local traces for considered functions and operators. GR-method presents the solution of the Dirichlet boundary value problem for this type of equations by explicit analytical formulas that use the direct and inverse Radon transform. Proposed version of GR-method is justified theoretically, realized as stable algorithms and program package in MATLAB system. The quality of constructed software is demonstrated by numerical experiments. Applications to the stationary problems of electrodynamics and HEAT TRANSFER thermo conductivity are discussed.

Brief Biography of the Speaker: Grebennikov Alexander Ivanovich was born at 17 of April 1950 in Gorky city, Russia. The student of the Faculty of Calculating Mathematics and Cybernetics (FCMC) of Gorky State University at 1967-1972. Postgraduate student of the FCMC of Moscow State University (MSU) at 1972-1975. Was graduated PhD in 1976. Scientific interests: splines; data processing; inverse and ill-posed problems; fast algorithms in numerical analysis and applications. Publications: more than 120 articles in journals and proceedings, 2 texts of lectures, 5 monographs. Work: assistant professor of the FCMC MSU at 1976-1989; senior staff scientist of Scientific Research Computing Center (SRCC) MSU at 1989-1994; Head of Laboratory in SRCC MSU at 1995-1999; full professor of the Faculty of Physic and Mathematic Sciences of Autonomous University of Puebla, Mexico from 1999 to present day.

Plenary Lecture 3

Flexibility in Mathematics Education: Leveraging the Power of the Spreadsheet

Associate Professor Steve Sugden
School of Information Technology
Bond University
Gold Coast, Queensland,
AUSTRALIA

Abstract: The common electronic spreadsheet may conjure up visions of accounting or auditing applications, however, it is a vastly underrated tool when it comes to illustration and modelling of mathematical fundamentals.
In 2002, the speaker established the electronic journal Spreadsheets in Education http://epublications.bond.edu.au/ejsie/. It was set up to provide a focus for researchers and teachers to share their ideas and experiences of using the modern electronic spreadsheet as a teaching tool. The journal is devoted to the publication of peer-reviewed articles which provide a focus for advances in our understanding of the role that spreadsheets can play in constructivist educational contexts. The first number of volume three of the journal was published in June 2008. The journal is fully open access.
The presentation will give a brief overview of major insights gleaned by researchers of roles played by the ubiquitous spreadsheet over the past 25 years in educational contexts. Following this, some examples will be given where Microsoft Excel is used to illustrate and model mathematical concepts, including applications to elementary financial and discrete mathematics.

Brief Biography of the Speaker: Steve Sugden is Associate Professor (Mathematics and Computation) at Bond University. He obtained his PhD in Operations Research (nonlinear integer programming) from Bond in 1992, working under the supervision of Professor Bruce Murtagh, creator of the AESOP and MINOS optimization packages. His scientific career has been rather diverse, with significant periods in industry, working in areas as diverse as solar energy, technical engineering software for various Queensland electricity authorities, and cryptographic software engineering. His present research interests at Bond centre on the use of technology in mathematics education, especially modern spreadsheet programs such as Microsoft's Excel. In 2002, he established the open access electronic journal Spreadsheets in Education, hosted at Bond. This journal publishes fully peer-reviewed articles plus classroom resources for teachers. In recent years, he has also been active in consulting work and has developed several mathematical models relating to aspects of Keno.

Plenary Lecture 4

Studying Modules Using Endomorphisms

Professor Ulrich Albrecht
Department of Mathematics and Statistics
Auburn University
U.S.A

Abstract: Many applications of algebra require a deep understanding of non-commutative rings and of the structure of modules over such rings. Unfortunately, the rich structure theory available for modules over integral domains appears to be not available in this more general setting. This lecture demonstrates that this is not the case by presenting an approach to studying modules over rings without requiring immediate restrictions on the ring. As most results in module-theory, our discussion has its roots in the theory of linear transformations of a (finite-dimensional) vector-space V. For a given right module M over a ring R, we consider the group E = E(M) of all R-linear transformations M ® M. Composition of maps makes E a ring, and M an E-R-bimodule. The ring E is called the endomorphism ring of M. We will discuss how ring-theoretic properties of the ring E are reflected in the structure of the module M and vice-versa. Examples of applications of this approach to several problems in Algebra will be given.

Brief Biography of the Speaker:
Education:
Universitat Essen Vordiplom (B.S.) 1978
Universitat Essen Diplom (M.S.) 1980
New Mexico State University Ph.D. 1982
Universitat Duisburg Habilitation 1986
Positions Held:
New Mexico State University Graduate Assistant 8/1980 - 5/1982
Universitat Essen Wissenschafliche Hilfskraft 5/1982 - 8/1982
Universitat Duisburg Wissenschaftlicher Angestellter 9/1982 - 8/1983
Marshall University Assistant Professor 8/1983 - 5/1984
Auburn University Assistant Professor 6/1984 - 9/1987
Auburn University Associate Professor 9/1987 - 9/1994
Auburn University Professor 9/1994 - 3/2000
Auburn University Professor and Chair 3/2000 - present
Areas of Research:
Abelian Groups, Ring Theory, Module Theory, Homological Algebra
Talks and Colloquia:
57 talks and colloquia
Papers in Refereed Journals:
60 appeared, 5 accepted, 5 submitted

Plenary Lecture 5

Reduction Methods for Approximate Solution of the Singular Integro-Differential Equations in Lebesgue Spaces

Professor Iurie Caraus
Department of Mathematics and Informatics
Moldova State University, Mateevici 60, str.,Chisinau
Moldova, MD-2009

Abstract: We obtain the numerical schemes of reduction methods for the approximate solution of the singular integro-differential equations. The equations are defined on the arbitrary smooth closed contour of complex plane. Theoretical background for these methods is proven in Lebesgue spaces.

Brief Biography of the Speaker: Iurie Caraus is Associate Professor on the Faculty of Mathematics and Informatics, Moldova State University, Chisinau. He obtained his PhD in Numerical Mathematics in 1998(Chisinau), working under the supervision of Prof. V. Zolotarevski. PhD Thesis title: The Numerical Methods for the Solution of Singular Integro-Differential Equations.
Visiting Universities
April 2006-June 2006 Junior, Visiting Researcher, Department of Mathematics and its Applications, Central European University, Budapest, Hungary,
February 2005- August 2005 Visiting Researcher, Department of Mathematics and Informatics, University of Trieste, Trieste, Italy,
15.09.04-14.12.04 Visiting Researcher, Technische Universitat, Faculty of Mathematics, Chemnitz, Germany,
January 2003-April 2003 Visiting Researcher, NC State University, Department of Mathematics, Raleigh, USA.
Fields of Scientific Interests
Collocation Methods, Singular Integral equations, Optimisation, Information Security, Mathematical Economics
Publications: more than 37th articles in journals and proceedings, 2 texts of lectures.

Plenary Lecture 6

On Devaney's Definition of Chaos for Discontinuous Dynamical Systems

Professor Byungik Kahng
University of Minnesota, Morris
Division of Science and Mathematics
600 E. 4th St. Morris, MN 56267
USA

Abstract: Probably the most widely accepted definition of chaos is the one by Devaney, which we will call Devaney-chaos. It consists of three conditions, (1) the sensitive dependence upon the initial condition, (2) the topological transitivity, and (3) the dense distribution of the periodic orbits. The third condition is often omitted for being too stringent. The purpose of our research is to investigate how the first two characteristic properties of Devaney-chaos are affected by the presence of the discontinuity.

Devaney-chaos is more inclusive than most of the competing notions of chaos, especially when the dynamics includes singularity. Recent discoveries by Goetz and Buzzi on the discontinuous dynamical systems include that the piecewise isometric dynamical systems, which are partly inspired by the digital signal processing and Hamiltonian dynamics, can generate complicated orbit structure, even though their Lyapunov-exponents and topological entropies are 0. Consequently, neither Lyapunov-chaos nor topological chaos can be applied to explain the complex behavior of the piecewise isometric dynamics. Goetz also proved that Smale-chaos fails to apply as well. Devaney-chaos, on the other hand, proved to be a useful tool, at least for some special cases, as exemplified by some of the author's earlier contributions.

We prove that Devaney-chaos can be used to successfully characterize the chaos that are generated by the discontinuity in general, if appropriate adjustments are made. Also, we show that the straightforward application of Devaney's conditions is too inclusive, when the system is discontinuous, consequently necessitating the afore-mentioned adjustments.

Plenary Lecture 7

Measures, Rates of Change for Solutions to Elliptic and Parabolic Equations and Square Functions

Professor Caroline Sweezy
Department of Mathematical Sciences
New Mexico State University
Las Cruces, New Mexico
USA

Abstract:

The rate of change of a temperature function in a confined region in Euclidean space, when there are heat sources within the domain, is of interest in physical applications. Starting with results concerning how the gradient of a temperature function with no internal sources can be controlled by the temperature on the boundary of a domain, we examine how the methods that have been successful in this situation can be changed to obtain similar information when heat sources are present. Certain techniques were used by Wheeden and Wilson, and later by the speaker and Wilson, to establish sufficient conditions on two measures, one, μ, on the interior of a bounded domain, Ω, and the other measure $v d\omega$ on the boundary of Ω, so there is a constant $C > 0$, such that

$$\left(\int_{\Omega} |\nabla u(x)|^q \, d\mu \right)^{1/q} \leq C \left(\int_{\partial\Omega} |f(x')|^p \, v(x') d\omega(x') \right)^{1/p}$$

for any solution $u(x)$ to the Dirichlet problem, $\Delta u = 0$ in Ω, $u|_{\partial\Omega} = f$. These methods can be adapted for solutions to the inhomogeneous equation, $Lu = g$ in Ω, $u|_{\partial\Omega} = 0$, to show that the rate of change of u is bounded by the heat source function, g. The history of work on both problems will be discussed, and results obtained for the inhomogeneous equation will be presented for the case when L is a strictly elliptic second order divergence form operator on a rough boundary (Lipschitz) domain.

Brief Biography of the Speaker: Caroline Sweezy received her degrees in mathematics at University of California at Los Angeles (UCLA): B.A. in 1980, M.A. in 1982 and Ph.D. in 1986. After two quarters of teaching at UCLA, she started at New Mexico State University (NMSU) in Fall 1986 as an assistant professor, was promoted to associate professor in 1996 and full professor in 2007. Her area of research is applications of harmonic analysis to solutions of second order partial differential equations, with some work on function spaces. She has published papers in Proceedings of the American Mathematical Society, Studia Mathematica, Annales Polonici, Rocky Mountain Journal of Mathematics, WSEAS Transactions and International Journal of Pure and Applied Mathematics. She has been supported by research grants from the National Science Foundation (NSF) and from NMSU; she has been a senior personnel on education grants from the United States Department of Education, NSF and the Sloan Foundation.

Plenary Lecture 8

Contributions to the Resolution of the Gibbs Phenomenon

Professor Nataniel Greene
City University of New York
Department of Mathematics and Computer Science
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Abstract: The Gibbs phenomenon refers to the lack of uniform convergence which occurs in many orthogonal basis approximations to piecewise smooth functions. This lack of uniform convergence is manifested as spurious oscillations near the points of discontinuity and a low order of convergence away from the discontinuities.
In this talk we review many of the methods which have been developed in recent years for dealing with this problem. We then describe some of our own contributions and ongoing investigations on the topic, including how wavelets can be used to obtain a multiresolution reconstruction of a function given its Fourier data.

Plenary Lecture 9

Overview of Differential Reduction for Hypergeometric Function Representation of Feynman Diagrams

Professor Bennie F. L. Ward
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Abstract: We present an overview of recent progress in the development of differential reduction algorithms for hypergeometric function representation higher order Feynman diagrams with an eye toward their use in precision theory predictions for LHC/CLIC physics.

Brief Biography of the Speaker: Dr. B.F.L. Ward is Distinguished Professor of Physics at Baylor University in Waco, TX, USA. His main research interests are the development and application of quantum field theory methods for precision high energy physics, especially as such methods relate to the Large Hadron Collider(LHC) at CERN and to the possible ILC/CLIC high energy e+e- colliders at the TeV scale. He has authored over 240 papers on these and related subjects and he has recently introduced a new approach to quantum gravity, resummed quantum gravity, which shows that the Einstein's theory is calculable when it is expressed in terms of exact, amplitude based resummation theory as he has developed for use in LHC physics in QCD, for example. He is an Editor for Research Letters in Physics and he is Co-Editor-in-Chief of The Open Nuclear and Particle Physics Journal. He is a Fellow in the American Physical Society.

Plenary Lecture 10

Multi-Key Search Algorithms - A new Paradigm in Algorithm Design

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Abstract: This talk is a consolidated representation of my recent research findings. Search algorithms are fundamental to the computing sciences with intensive database applications. So far, a significant amount of efforts has been set forth to improving the computer-based search strategies. Multi-element search techniques are relatively new in computer science. I have introduced this concept at the 8th World Multi-Conference on Systemics, Cybernetics and Informatics back in 2004. The multiple key search algorithms may effectively be combined with the traditional concepts prevailing in the data structure literature to optimize the computer-based resource requirements for certain applications. Further research in this area has appeared to be appealing in integrating these concepts with the traditional designs prevailing in the algorithmic. Among the most useful search algorithms, interpolation search uses the concept of projection for equally separated elements inside a given list. An extended multiple key interpolation search algorithm is developed and implemented, which has time and computational memory requirements much less than the other algorithms in this class with multiple key search criteria and equally separated list of elements. The idea of Block Search is to subdivide a given list of sorted elements into equally sized blocks, and then restrict the search effort into one of these blocks. The concept pertaining to multiple search elements fits nicely with the idea prevailing in Block Search. This hybrid algorithm has the best performance whenever an element to search for exists at each division point of each independent block within the current tier. In that event, the time required by the new algorithm is linear, and proportional to the number of elements to look for. It is also possible to sub-divide each independent block into multiple numbers of sub-blocks and then reapply the multiple element block search strategy to each independent block containing a number of sub-blocks. Though this increases the complexity of algorithm design, but due to the improved efficiency, the algorithm will require substantially less computational resources. The optimum number of tiers for the computational resources requirements is also investigated. The basic binary search technique may be combined with the multi-tier multiple key block search strategy.

Brief Biography of the Speaker: Dr. Ahmed Tarek is an Associate Professor of Computer Science, Computer Science Program Chair and the B.S. in Computer Science Accreditation Leader at California University of Pennsylvania (also called the Cal U). He is currently affiliated with Cal U's Department of Math and Computer Science in the Eberly College of Science & Technology. Prior to joining the Cal U faculty, Dr. Tarek has taught Computer Science to both the graduate and the undergraduate programs at Eastern Kentucky University for a number of years.

Dr. Tarek's research interests include but are not limited to design and analysis of algorithms, data structures, discrete computational structures, computational complexity, software engineering, real-time software systems and operating systems. So far he has published more than 20 papers in different international journals and conference proceedings. Besides, he has also made a number of presentations to different international conferences and symposiums, and served as the Session Chair to a number of conference sessions.

Right from the beginning of his professional career till today, Dr. Tarek has taught a number of graduate and undergraduate Computer Science, Computing Sciences and Information Sciences courses to different US and British universities abroad. For his achievements, he has been recognized by the Marquis Publications in the United States of America. His biography has regularly appeared in Marquis Publications' Who's Who in Science and Engineering since it's 9th edition, Who's Who in the World since the 25th Silver Anniversary Edition and also in the Who's Who in America since the 61st edition.

For his contributions to the education and the academia, he has been recognized by the editorial board of the International Biographical Centre (IBC) at Cambridge in England by providing Membership to the IBC in 2008. IBC has decreed him as the IBC's Leading Educator of the World, 2008 and the IBC's Leading Scientist of the World, 2008. IBC has also granted him the 21st Century Award for Achievement. His biography has been included in the IBC's Cambridge Blue Book, 2000 Outstanding Intellectuals of the 21st Century, and also in the Dictionary of International Biography.

Plenary Lecture 11

GPS-based Optimal FIR Filtering of Discrete-time Clock Models

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Abstract: Although Time is a perfect eraser of any information (we have only a few evidences of ancient civilizations), modern digital information technologies rely on an extremely high accuracy of local timescales. The function of time dissemination is ordered to the Global Navigation Satellite Systems (GNSS) such as the Global Positioning System (GPS) measuring up to world standards for signals and systems. Even so, precision of the disseminated time is limited with noise, which standard deviation using commercially available timing receivers is about 30 ns, can reach 10-20 ns and may be improved by removal of systematic errors to no less than 3-5 ns. Precise correction of the local clock errors is hence not always available and optimal estimators are used. The problem we meet here is coupled with the nonstationary random behavior of the clock TIE and the GPS time temporary uncertainties caused by different satellites in a view. It arises in connection with the non Gaussian sawtooth noise induced by the receiver owing to the principle of the one pulse per second (1PPS) signal formation and with the non-white (colored) Gaussian noise of the clock oscillator. Under such conditions, the standard Kalman algorithm cannot always be used properly and may become noisy and unstable.This lecture introduces readers to the finite impulse response (FIR) filtering approach in applications to GPS-based measurements of the local clock errors. Precision of such measurements is limited by the GPS time temporary uncertainty and non Gaussian sawtooth noise induces by the GPS timing receiver. Therefore, optimal solutions are needed to estimate the clock instabilities. We give the fundamentals of FIR filtering, prediction, and smoothing of the polynomial and state space clock models. Unbiased and optimal FIR solutions are observed in line with the basic and thinning algorithms. The trade-off with the Kalman-Bucy algorithm is also discussed. It is noticed that, for large averaging horizons featured to slowly changing with time clock models, simple unbiased FIR solutions become virtually optimal. They may be the best choice in terms of simplicity, precision, stability, and robustness in solving many of the clock problems in GPS-based timekeeping and clock synchronization. Although, we discuss mostly an applied computation problem associated with accurate estimation of clock models, the results are readily extended to general polynomial discrete-time state space models.

Brief Biography of the Speaker: Dr. Yuriy S. Shmaliy is a Full Professor of Electronics of the School of Mechanical, Electrical, and Electronic Engineering (FIMEE) of the University of Guanajuato, Mexico. He received the B.S., M.S., and Ph.D. degrees in 1974, 1976 and 1982, respectively, from the Kharkiv Aviation Institute, Ukraine, all in Electrical Engineering. In 1992 he received the Doctor of Technical Sc. degree from the Kharkiv Railroad Institute. In March 1985, he joined the Kharkiv Military University of Ukraine. He serves as Full Professor beginning in 1986 and has a certificate of Professor from the Ukrainian Government in 1993. Since 1993 to 1999, he has been a director-collaborator of the Scientific Center “Sichron” (Kharkiv, Ukraine) working in the field of precision time. In 1999, he joined the Kharkiv National University of Radio Electronics, and, since November 1999, he has been with the Guanajuato University of Mexico as a full professor with tenure. Dr. Shmaliy has 14 books, handbooks, and manuals. He has 240 Journal and Conference papers and 80 patents. His textbooks Continuous-Time Signals and Continuous-Time Systems intended for students of all levels of education were published by Springer. He was rewarded a title, Honorary Radio Engineer of the USSR, in 1991; was listed in Marquis Who's Who in the World in 1998; and was listed in Outstanding People of the 20th Century, Cambridge, England in 1999. He is a Senior Member of the IEEE and belongs to several other professional Societies. He is a member of the Organizing and Program Committees of various Int. Symposia. He is a founder and organizer of the Int. Symposium on Precision Oscillators in Electronics and Optics. His current interests include the stochastic systems theory, precision resonators and oscillators, probabilistic methods of information theory, and computational methods of optimal estimation and statistical signal processing.

Plenary Lecture 12

A Critical Review of the Mathematical Robustness of Genetic Algorithms in Optimization Problems

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Abstract: Genetic Algorithms (GAs) have been shown to be particularly effective in many optimization problems due to their ability to search in a continuous space without getting trapped in local optima while exploiting the entire search space. Some recent research works however, show that the mathematical theory of GAs are not fully understood and its validity may be questioned. This may affect the quality and reliability of solutions obtained from the GA optimization process. In addition, sensitivity of critical parameters in GAs may also affect the quality of solution. If GAs are applied properly, similar solutions should be expected at each replication, regardless of where the search process starts. Some of the critical parameters affecting search performance include the number of genetic operators, the number of decision variables, the parameter for selective pressure, and the parameter for non-uniform mutation.

In this presentation I provide a critical review of the mathematical foundation of GAs and also show a sensitivity analysis of the critical parameters that may affect the quality of solutions. Attention is directed specifically to the schema theory, which are considered to be the building blocks for GA operation. Using my previous collaborative work with Dr. David Lovell of the University of Maryland, College Park I show a hard upper bound on the number of matching schemata in binary and real coded GAs for a population of a given size and string length. A loose upper bound is commonly reported in the published literature, but does not take into account redundancies that are inevitable for certain values of the population size. In this ppresentation, this over-counting is rectified. A special case when the string length is small compared to the population size is shown to have a particularly elegant solution. In order to investigate the effects of critical parameters when adopting GAs I show a sensitivity analysis using previous collaborative work with Dr. Eungcheol Kim of the University of Incheon, South Korea, which shows that quality of solutions depend on their proximity of convergence from different starting points. Finally, we investigate the improvement in solution quality with the derived hard upper bound.

Brief Biography of the Speaker: Dr. Manoj K. Jha is Associate Professor and Founding Director of the Center for Advanced Transportation and Infrastructure Engineering Research (CATIER) in the department of civil engineering at the Morgan State University, Baltimore, MD, USA. He obtained a Ph.D. in Civil Engineering with transportation specialization from the University of Maryland, College Park in 2000; a M.S. degree in Mechanical Engineering from the Old Dominion University in 1993; and a B.E. degree in Mechanical Engineering from the National Institute of Technology, Durgapur, India in 1991. He also attended the Rensselaer Polytechnic Institute during 1993-94 as a Ph.D. student in Mechanical Engineering and Virginia Tech.'s National Capital campus as a post doctoral fellow during 2000-2001.

Dr. Jha's research interests are in investigating mathematic foundation of artificial intelligence-based optimization algorithms, and highway route optimization and visualization. For his scholastic and research achievements Dr. Jha has received several awards, among which are the 2005 and 2006 United Negro College Funds Special Program/Department of Defense (UNCFSP/DoD) Faculty Development Award, 2005 Department of Homeland Security (DHS) Summer Faculty Research award by the Study of Terrorism and Responses to Terrorism (START) Center of Excellence, University of Maryland, College Park, and 2005 NSF-PASI-TS (National Science Foundation's Pan-American Advanced Study Institute on Transportation Sciences) award by the Rensselaer Polytechnic Institute. He is a registered Professional Engineer in the State of Maryland since 1997.

Dr. Jha has served as a PI, Co-PI, or collaborator with other researchers on numerous research project totaling over $4 million. The key sponsoring agencies of his research projects include Army Research Lab., Maryland State Highway Administration, Federal Highway Administration, National Science Foundation, and several Baltimore area consulting firms. Dr. Jha has authored (or co-authored) more than 90 articles in journals, books, and conference proceedings in the highway design, optimization, and transportation literature. He has also co-authored 2 books on road design entitled "Intelligent Road Design" and "Fundamentals of Road Design."

Plenary Lecture 13

Synergy Analysis in Reaction Systems

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Abstract: This work introduces the concept of analysis of synergy interactions in chemical (biochemical) reaction systems. The systems are defined by mass balances for reacting species, reaction network given by a stoichiometric matrix, reaction (kinetic) parameters, and parameters of interaction between the reaction system and a surrounding. Systems analysis is based on statistical evaluation of numerical results of computer simulation of effects of a set of uncorrelated stochastic parameters, defined by corresponding ranges and probability distributions. From the simulation data are extracted parameter global sensitivities and synergy effect of each parameter in interaction with the whole system. The global parameter sensitivities are defined as ratios of conditional variances of expected values for each parameter and the total dispersion of simulation data. The synergy effects are defined as the relative difference between expected values of the conditional variances with exclusion of each parameter and the variance of the conditional expected value of the parameter. Numerical evaluations are performed by use of sampling the parametric space by Lissajous type of curves and the Fourier Amplitude Sensitivity Test (FAST) algorithm. The method is applied for analysis of propagation hepatitis B virus (HBV) in a stochastic single cell model, and for metabolic control analysis of a branched network. The results for virus propagation show dominant synergy effect of the system parameters, compared to negligible influence of individual parameters. The metabolic control analysis show that under homeostatic conditions influence of the individual enzymes is dominant and the key enzyme responsible for flux regulation is determined. However, under perturbed homeostatic conditions influence of synergy effects dominates over impact of individual parameters. Applicability of the proposed concept is discussed in view of model improvement and potential control of reaction systems.

Brief Biography of the Speaker: Zelimir Kurtanjek was born in 1946 in Zagreb, Croatia. He graduated in 1971 with engineering degree in physics from the Department of Sciences, University of Zagreb. He completed postgraduate studies in Technical Cybernetics at Faculty of Technology, University of Zagreb. In 1975 he enrolled at the postgraduate study in chemical engineering at the Department of Chemical Engineering, The University of Houston, TX, USA. In 1979 he received doctoral degree under mentorship of Prof. Dan Luss in the Laboratory for Reaction Engineering. He completed his postdoctoral studies with Prof. G. Froment at the Department of Chemical Engineering, University of Gent, Belgium. During 1991. he was a visiting professor through EU project TEMPUS at the Department of Biological Sciences, University of Ulster, Coleraine, Northern Ireland. Since 1980 he is employed at the University of Zagreb, Faculty of Food Technology and Biotechnology, University of Zagreb as a professor of chemical engineering. He is teaching reactor engineering, mathematical modeling and process control to students of biochemical, chemical and food engineering. In his scientific work he is interested in modeling and control of reactors, modeling of bioprocesses and food processes, and application of AI methods in modeling and process control. He has published over 50 papers in international and national journals. Since 1976 he is a member of American Institute of Chemical Engineers, a delegate of Croatia in European Federation of Biotechnology, and also is a member of Croatian Society of Chemical Engineers, Croatian Society of Biotechnology, and Croatian Technical Academy. He is editor in chief of Chemical and Biochemical Engineering Quarterly and a member of the editorial board of Food Technology and Biotechnology journals.