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Recent Advances in Applied Mathematics, Modelling and Simulation

Editors

Nikos E. Mastorakis

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Nitis Mukhopadhyay

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Proceedings of the 8th International Conference on Applied Mathematics, Simulation, Modelling (ASM '14)

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Editors:
Prof. Nikos E. Mastorakis, Technical University of Sofia, Bulgaria
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Prof. Nitis Mukhopadhyay, University of Connecticut, USA
Prof. Francesco Mainardi, University of Bologna & INFN, Italy

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Keynote Lecture 1

Most Recent Developments within Enhanced Multivariance Products Representation (EMPR) Perspective

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Abstract: A few years ago, Metin Demiralp has constructed an extension to High Dimensional Model Representation (HDMR) by inserting certain given univariate functions, support functions, to the formulation. This extension has been called "Enhanced Multivariance Products Representation (EMPR)" because of the additive terms with unique common multivariance same as the number of the target function's independent variables. After this construction, during the time period, from then until now, he and his group (Group for Science and Methods of Computing in ˙Istanbul Tehcnical University Informatics Institute) members performed various applications and created new developments.

EMPR preserves the orthogonal geometry of HDMR. It also uses the product type overall weight functions which are composed of univariate factors, each of which depends on a different independent variable argument of the target function; even though quite recently nonproduct type overall weights are succesfully introduced to the formulation of HDMR. Beyond these preservations, the basic extension is to multiply each HDMR component with certain univariate support functions such that the resulting form of the component becomes dependent of all independent variables of target function. The support functions are given entities and, depending on how they are defined, the EMPR truncations show different level of approximation qualities. Hence, the support function selection is perhaps the most important component of EMPR.

EMPR has born from the image processing via HDMR upon noticing its certain in sufficiencies within technicalities. The bivariate HDMR has been used therein and soon it has been noticed that the all of the three different type HDMR truncations were giving almost nothing and the bivariate remainder term was involving overdominating pixel information about the target image with slightly depending on which kind of weight has been used. This motivated us to change, or truely speaking, extend HDMR philosophy by importing support functions. The result has been really more acceptable when the dimensionality grows. Even though there has been a noticable quality increase even in the case of bivariance, bivariate EMPR has appeared to be quite limited and urged us to seek more than one sets of support functions to extend HDMR. The result has been quite succesfull and TMEMPR (Tridiagonal Matrix EMPR) for discrete set domains and TKEMPR (Tridiagonal Kernel EMPR) for continuous functions which can be considered as the kernel of an appropriate univariate integral operator have born after these efforts.

The presentation focuses on these and some related issues in somehow chronological order.

Brief Biography of the Speaker: Metin Demiralp was born in Türkiye (Turkey) on 4 May 1948. His education from elementary school to university was entirely in Turkey. He got his BS, MS degrees and PhD from the same institution, ˙Istanbul Technical University. He was originally chemical engineer, however, through theoretical chemistry, applied mathematics, and computational science years he was mostly working on methodology for computational sciences and he is continuing to do so. He has a group (Group for Science and Methods of Computing) in Informatics Institute of ˙Istanbul Technical University (he is the founder of this institute). He collaborated with the Prof. Herschel A. Rabitz's group at Princeton University (NJ, USA) at summer and winter semester breaks during the period 1985-2003 after his 14 month long postdoctoral visit to the same group in 1979-1980. He was also (and still is) in collaboration with a neuroscience group at the Psychology Department in the University of Michigan at Ann Arbour in last three years (with certain publications in journals and proceedings).

Metin Demiralp has more than 100 papers in well known and prestigious scientific journals, and, more than 230 contributions together with various keynote, plenary, and, tutorial talks to the proceedings of various international conferences. He gave many invited talks in various prestigious scientific meetings and academic institutions. He has a good scientific reputation in his country and he was one of the principal members of Turkish Academy of Sciences since 1994. He has resigned on June 2012 because of the governmental decree changing the structure of the

academy and putting politicial influence possibility by bringing a member assignation system. Metin Demiralp is also a member of European Mathematical Society. He has also two important awards of turkish scientific establishments.
The important recent foci in research areas of Metin Demiralp can be roughly listed as follows: Probabilistic Evolution Method in Explicit ODE Solutions and in Quantum and Liouville Mechanics, Fluctuation Expansions in Matrix Representations, High Dimensional Model Representations, Space Extension Methods, Data Processing via Multivariate Analytical Tools, Multivariate Numerical Integration via New Efficient Approaches, Matrix Decompositions, Multiway Array Decompositions, Enhanced Multivariate Product Representations, Quantum Optimal Control.

Plenary Lecture 1

Fractional Diffusive Waves Generated by Evolution Equations of Fractional Order

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Abstract: In this lecture we discuss some properties of the Cauchy and signaling problems for the one-dimensional time-fractional diffusion-wave equation with the time fractional derivative of order beta (1< beta <2) . In particular, their response to a localized disturbance of the initial data is studied. It is known that whereas the diffusion equation describes a process where the disturbance spreads infinitely fast, the propagation velocity of the disturbance is a constant for the wave equation. We show that the time-fractional diffusion-wave equation interpolates between these two different responses in the sense that the propagation velocities of the maximum points, centers of gravity, and medians of the fundamental solutions to both the Cauchy and the signaling problems are allfinite. On the other hand, the disturbance spreads infinitely fast and the time-fractional diffusion-wave equation is non-relativistic like the classical diffusion equation. Furthermore, the maximum locations, the centers of gravity, and the medians of the fundamental solution to the Cauchy and signaling problems and their propagation velocities are described analytically and calculated numerically. The obtained results for the Cauchy and the signalling problems are interpreted and compared to each other.

Brief Biography of the Speaker: Presently Francesco MAINARDI is retired professor of Mathematical Physics from the University of Bologna where has taught this course since 40 years. His fields of research concern several topics of applied mathematics, including diffusion and wave problems, asymptotic methods, integral transforms, special functions, fractional calculus and non-Gaussian stochastic processes. At present his H-index is > 40 For a full biography, list of references on author's papers and books see:
Home Page: http://www.fracalmo.org/mainardi/index.htm and
http://scholar.google.com/citations?user=UYxWyEEAAAAJ&hl=en&oi=ao

Plenary Lecture 2

On Fundamental Sequential Confidence Interval Estimation Problems Revisited

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Abstract: The literature on fundamental sequential confidence interval estimation problems had major breakthroughs with significant richness after the appearance of pioneering contributions of Dantzig (1940, Annals of Mathematical Statistics), Stein (1945, Annals of Mathematical Statistics), Anscombe (1952, Proceedings of Cambridge Philosophical Society), and Chow and Robbins (1965, Annals of Mathematical Statistics). This area was elegantly synthesized along with new directions for research by Ghosh and Mukhopadhyay (1976, Sankhya, Series B).
The literature has since grown tremendously in many directions with incorporation of operationally convenient multi-stage and computer-intensive sampling methods having first-, and often second-order, asymptotic properties. One will find many important directions from the texts of Mukhopadhyay and Solanky (Multistage Selection and Ranking Procedures, 1994, Dekker), Ghosh, Mukhopadhyay, and Sen (Sequential Estimation, 1997, Wiley), Mukhopadhyay, Datta, and Chattopadhyay (Applied Sequential Methodologies, 2004, Dekker), Mukhopadhyay and de Silva (Sequential Methods and Their Applications, 2009, CRC Press), and others.
In this plenary lecture, I will begin by summarizing the original contributions of Dantzig, Stein, Anscombe, and Chow and Robbins. Then, I will move to emphasize a clear roadmap linking some of the major methodological and theoretical developments from past 40 years. Real applications will be highlighted when appropriate.

Brief Biography of the Speaker: Professor Nitis Mukhopadhyay received his PhD degree awarded by the Indian Statistical Institute-Calcutta based on a dissertation dated 1975. He has been a full professor in the Department of Statistics at the University of Connecticut-Storrs, USA since 1985. He served as the Head of this department during 1987-1990.
He has made prolific contributions in many areas including statistical inference -parametric and nonparametric, multiple comparisons, clinical trials, applied probability, and applications. Professor Mukhopadhyay is especially revered for path-breaking contributions in sequential analysis as well as selection and ranking. His honors include elected Fellows of the Institute of Mathematical Statistics (2002), the American Statistical Association (2003), the American Association for the Advancement of Science (2012), elected Ordinary Member of the International Statistical Institute (2007), elected Member of the Connecticut Academy of Arts and Sciences (2014), and the Abraham Wald Prize in Sequential Analysis (2008). He is the Editor-in-Chief for the premier journal, Sequential Analysis, and serves as an Associate Editor for a number of leading international journals.
Professor Mukhopadhyay is the author or co-author of 6 books, 14 book chapters, more than 215 research papers, and editor or co-editor of 6 special volumes. He has supervised 22 PhD students as their major adviser. For more details, one may visit the website: http://www.stat.uconn.edu/~nitis/.

Plenary Lecture 3

On Maximum Likelihood Clustering via a Multimodal Probability Model

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Abstract: Clustering is a method for finding structure in a data set. Clustering methods can be generally categorized as either having a (probability) model-based approach or a nonparametric approach. For a model-based approach, there are two ways to use a probability model for clustering. One is based on the expectation & maximization (EM), and the other is based on the classification maximum likelihood (CML). For a nonparametric approach, clustering methods are generally based on an objective function of similarity or dissimilarity measures, and partitional methods are popularly used, such as k-means and fuzzy c-means, etc. In this lecture, we first consider the maximum likelihood (ML) estimation for the proposed multimodal probability model (MPM) to establish an ML clustering approach. According to the ML clustering, the relationships between most clustering algorithms and the MPM are established. We find that the MPM is actually a good basic probability model for most clustering methods. This ML clustering approach can lead to most clustering algorithms, such as EM, CML, k-means, fuzzy c-means, possibilistic c-means, mean shift, and latent class methods. We then construct two ML clustering frameworks based on the MPM for developing new clustering algorithms. One framework can develop penalized-type clustering algorithms. Another framework induces entropy-type clustering algorithms, especially with sample-weighted clustering. Several numerical and real data sets are made for comparisons. These experimental results show that these new constructions based on the ML clustering can produce useful and effective clustering algorithms.

Brief Biography of the Speaker: Prof. Miin-Shen Yang received the BS degree in mathematics from the Chung Yuan Christian University, Chung-Li, Taiwan, in 1977, the MS degree in applied mathematics from the National Chiao-Tung University, Hsinchu, Taiwan, in 1980, and the PhD degree in statistics from the University of South Carolina, Columbia, USA, in 1989.

In 1989, he joined the faculty of the Department of Mathematics in the Chung Yuan Christian University (CYCU) as an Associate Professor, where, since 1994, he has been a Professor. From 1997 to 1998, he was a Visiting Professor with the Department of Industrial Engineering, University of Washington, Seattle. During 2001-2005, he was the Chairman of the Department of Applied Mathematics in CYCU and now, he is the Director of Chaplain's Office in CYCU. His research interests include applications of statistics, fuzzy clustering, neural fuzzy systems, pattern recognition and machine learning.

Dr. Yang was an Associate Editor of the IEEE Transactions on Fuzzy Systems (2005-2011), and is an Associate Editor of the Applied Computational Intelligence & Soft Computing and Editor-in-Chief of Advances in Computational Research. He was awarded with 2008 Outstanding Associate Editor of IEEE Transactions on Fuzzy Systems, IEEE; 2009 Outstanding Research Professor of Chung Yuan Christian University; 2010 Top Cited Article Award 2005-2010, Pattern Recognition Letters; 2012 Distinguished Professor of Chung Yuan Christian University; 2014 overseas academic scholar for The 111 Plan of China.

Plenary Lecture 4

Geometrical Numerical Techniques for the Approximation of Ecological Models Described by Nonlinear Differential Equations

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Abstract: A major neglected weakness of many current (non trivial) ecological models is the numerical method used to solve the governing systems of differential equations (DEs). Indeed, the discrete dynamics of the approximations of DEs may provide spurious numerical behaviour. This indicates that many problems widely believed to be endemic to the models, are frequently merely artifacts of their numerical implementation. The approach represented by the geometric numerical integration, by preserving qualitative properties of the solution, leads to improved long-time numerical behaviour. Therefore geometric integration methods should be used for preserving one or more of the properties (positivity of the phase space, Poisson structure, invariants) that characterize the continuous ecological models. The effectiveness of this approach will be shown with some examples of population dynamics.

Brief Biography of the Speaker: Dr. Fasma Diele (female), Master degree in Mathematics, researcher at Istituto per Applicazioni del Calcolo "M.Picone" of the Consiglio Nazionale delle Ricerche (CNR) since 1998, she is the Head of the IAC Research Unit located in Bari. She is author of several papers in numerical analysis and scientific computing. She was referee for Italian University and Research Ministry (MIUR) in the area of Numerical Analysis. She was referee for Proposals in Mathematics of the National Research Fund for Scientific & Technological Development (FONDECYT), Chile. She is reviewer for several mathematics journals such as SIMAX, SINUM, SISC. She is member of the editorial board of Journal of Computer Science and Abstract and Applied Analysis. Her area of expertise is the field of Geometric Numerical Integration of non linear differential equations: methods for preserving invariants, energy-preserving methods, symplectic partitioned Runge-Kutta methods, splitting and composition methods. She was research leader of RSTL id.332 project (funded by CNR), "Numerical algorithms for differential equations with specific qualitative properties". She participated to the FP7-SPACE.2010.1.1-04 project BIO_SOS developing her research activity on symplectic methods for simulating population and metapopulation dynamics in fragmented habitat.