

Recent Advances in Education and Educational Technologies

**Proceedings of the 2013 International Conference on
Education and Educational Technologies (EET 2013)**

Rhodes Island, Greece, July 16-19, 2013

Edited by

Charles A. Long
Nikos E. Mastorakis
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Keynote Lecture 1

Shifting the Expansion Point in Direct Power Series of Multivaried Functions



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Abstract: Taylor series play an important role in the representation of the analytic functions. They are in fact certain infinite linear combinations of some power functions which are linearly independent despite their functional dependence. These series are valid not only for univariate functions, their multivariate versions are also capable of representing the target function. However, the expressions of multivariate functions become complicated because of the high number of terms when the number of the independent variables increases. We generally need to use high number of indices and multiple sums for the representation. This may necessitate the multivariate algebra and its tools. On the other hand the use of the direct powers based on direct product, or Kronecker product at the remembrance of the relevant scientist, then everything can be handled just by using the ordinary linear algebra and its tools in a one index notation.

The direct power series of a function of n independent variables, x_1, \dots, x_n can be given as follows

$$f(x_1, \dots, x_n) = \sum_{j=0}^{\infty} \mathbf{F}_j \mathbf{x}^{\otimes j}$$

where the vector \mathbf{x} has the elements from x_1 to x_n inclusive while \mathbf{F}_j stands for a constant rectangular matrix of $n \times n^j$ type. The elements of \mathbf{F}_j are related to the partial derivatives of the left hand side function f . The symbol \otimes is for the direct power which can be recursively defined as follows

$$\mathbf{x}^{\otimes j} = \begin{bmatrix} x_1 \mathbf{x}^{\otimes j-1} \\ \vdots \\ x_n \mathbf{x}^{\otimes j-1} \end{bmatrix}, \quad j = 0, 1, 2, \dots$$

To initialize this recursion we take the zeroth direct power of a vector just as the scalar 1 by following the well-known convention of algebra. This produces the vector \mathbf{x} at the first direct power and therefore contains n elements. The number of the elements in the direct product increases as the degree of the direct product increases. Hence, $\mathbf{x}^{\otimes 2}$, in other words, the direct square of the vector \mathbf{x} , is composed of all possible binary products of the elements of \mathbf{x} by considering different ordering of the same product factors separately even though they are same because of the commutativity. The number of the elements in this case is n^2 . These

considerations can be extended to the case of general direct product with, say, j th degree. Then all possible j -factor products of the elements of x form the resulting vector whose number of elements is n^j .

The coefficient matrices F_j s are not unique because of the existence of same j -factor products as the elements residing at different locations in the j th direct power of x . There are certain rectangular matrices under the action of which the j th direct power of x vanishes. This brings the possibility of introducing certain flexibility parameters to the coefficient matrices. These flexibilities can be used to give certain specific natures to the coefficient matrices.

The replacement of x by $(y + a)$ in (1) and the rearrangement of the resulting expression in direct power series of the variable vector y produces another representation for the same original function. However, now, all coefficient matrices become the function of the constant vector a . All derivatives now should be somehow related to the partial derivatives of the original function evaluated at not origin but the point characterized by a . This is apparently a shift of the expansion point and the construction is not so straightforward as maybe considered at the very first glance because of the multivariate structure of the direct product operation. The noncommutativity in the representation may produce certain complications. However they can be handled by using some permutation matrices. Presentation will focus on these issues in certain detail as much as possible.

Brief Biography of the Speaker: Metin Demiralp was born in Turkiye (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 Arbor 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 political 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

Intelligent Prediction of Vehicle Dynamics Using Structured Neural Networks

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Abstract: The majority of traffic accidents today are caused by human errors in judgment and driving reaction. With the advance of microelectronics driver assistance systems (DAS) have been developed and became one of the principal priorities for most vehicle manufacturers. Obstacle avoidance or collision avoidance systems fall into this category and have naturally addressed the interest of many researchers during the last decade. These systems warn the driver or intervene using the braking/steering system based on the output of a decision algorithm. This algorithm calculates at each time instant a threat factor which represents the probability to get involved in a crash in the near future. This paper is focused on the intelligent prediction of the vehicle dynamics in the near future using a structured neural network approach. A nonlinear vehicle model with four degrees has been utilized. As will be shown, by means of simulation in Matlab, it is possible to predict the response of the vehicle with minimal computational burden. Therefore, the threat assessment can be enhanced and the performance of the decision algorithm improved. False alarms which determine the driver acceptance as well as liability issues are largely dependent on its performance.

Brief Biography of the Speaker: Dr S. Kanarachos holds a Diploma (5 years) and a PhD in Mechanical Engineering (2004) from the National Technical University of Athens (Hellas). He has worked as a consultant on product development (2001-2005) and researcher at the Mechanical Engineering Department of NTUA. From 2005-2007, he served the Department of Mechanical Engineering at Frederick Institute of Technology (Cyprus) as a Lecturer and from 2007-2012 the Department of Mechanical Engineering at Frederick University (Cyprus) as Assistant Professor specializing in the fields of Computational Dynamics & Numerical Optimization. From 2012 and onwards he works at the Integrated Vehicle Safety expertise group of TNO (The Netherlands) and from 2013 he is the head of the Vehicle Dynamics group. His research interests include: flexible multibody dynamics, finite element & multibody dynamics code coupling, metamodeling using structured neural networks and model reduction. He is the author of 15 publications in highly rated ISI journals and 50 in conference proceedings (of IEEE, WSEAS, etc.). He has participated as the principal researcher, coordinator or scientific supervisor in more than twenty research projects funded by National or European Framework Programmes (GSRT, RPF, FP6, FP7). He serves as a reviewer in several Scientific journals and conferences and he is member of the editorial board of the International Journal of Vehicle Systems Modelling and Testing. He has served as an evaluator of research projects for National & European Framework Programmes.

Plenary Lecture 2

Multitime Solitons and Their Maple Animation



Professor Constantin Udriste

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Abstract: The development of multitime PDE concepts is now in vogue in physics (multitime Maxwell PDEs), in electronics (widely-separated time scales, difference-frequency time scales, etc) and in mathematics (multitime solitons, introduced and analyzed in our research group). Indeed, to handle frequency-modulation effectively, it is necessary to use a novel concept, known as warped time, within a multitime partial differential equation framework. Generally, the purpose of a multi-dimensional model is to represent efficiently phenomena including widely separated time scales (for example, control of composite systems via the multi time-scale approach). An m-soliton is a special wave whose temporal evolution is m-dimensional. Of course, a multitime simulation requires special integrators and animations. For a two-time soliton, we prefer to adopt Maple Animation in 3d, creating spectacular evolutions.

Brief Biography of the Speaker:

Important Career Positions: Emeritus Professor, Consultant Professor, Dean, Director, Chair, Full Professor 1990-, University Politehnica of Bucharest, Department of Mathematics-Informatics.

Number of PhD Students: 25 in due time and 21 Doctors in Mathematics.

Membership of Associations: AMS, 1987; Tensor Society, 1985; Balkan Society of Geometers, President, 1994;

Publications: over 50 books; 300 papers; 300 communications.

Honors: D. Hurmuzescu Prize, Romanian Academy, 1985; Award MEI, 1988; Correspondent Member, Academia Peloritana, Messina, 1997; Prize COPIRO - 2000 for Exact Sciences; Premio Anassiloos International 2002, Arte Cultura Scienze, Italy; Titular Member, Academy of Romanian Scientists, 2007; Honorary Member, World Scientific and Engineering Academy and Society, 2008-; Stefan Hepites Prize, Academy of Romania, 2010.

Organizer: Chair-Committee: American Conference on Applied Mathematics (Math '08) and Management, Marketing and Finances (MMF '08), Cambridge, Massachusetts, USA, March 24-26, 2008. International Program Committee: The Applied Computing Conference (ACC-08), Istanbul, Turkey, May 27-30, 2008; The International Conference of Differential Geometry and Dynamical Systems (DGDS-2009), October 8 - 11, 2009, University Politehnica of Bucharest, Bucharest, Romania; European Computing Conference (ECC-09), 115-119, Tbilisi, Georgia, June

26-28, 2009; The International Conference of Differential Geometry and Dynamical Systems (DGDS-2010), 25-28 August 2010, University Politehnica of Bucharest , Romania.
Fields of Interest: Differential Geometry, Optimizations on Riemannian Manifolds, Magnetic Dynamical Systems, Geometric Dynamics.

Plenary Lecture 3

Invariant Subspaces and Structural Properties of 2-D Control Systems



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Abstract: Since its birth about sixty years ago, Systems Theory has developed into a scientific and engineering discipline connected with all aspects of modern society. At the beginning it was studied as Control Theory by mathematicians and engineers, but soon Systems Theory extended to the study and the applications of various domains such as economics, business, political science, sociology, medicine, biology, psychology, ecology etc. The past three decades have seen a continually growing interest of many researchers in the theory of two-dimensional (2D), which became a distinct and important branch of the Systems Theory. Two-dimensional models were developed in a series of papers by Roesser [15], Fornasini and Marchesini [4], Attasi [1], Eising [3] and others [6], [7], [12], [13]. The reasons for the interest in this domain are on one side the richness in potential application fields and on the other side the richness and significance of the theoretical approaches. The application fields include circuits, control and signal processing, image processing (which is the core of this approach), computer tomography, seismology, control of multipass processes [16], [17], iterative learning control [8] etc.

The invariant subspaces with respect to linear transformations represent the fundamentals of the Geometric Approach, which is one of the main trends in Systems and Control Theory.

Geometric Approach provides a very clear concept of minimality and explicit geometric conditions for controllability, observability, constructibility, pole assignability, tracking or regulation etc. These concepts are used to obtain efficient and elegant solutions of important problems of controller synthesis such as decoupling and pole-assignment problems or the compensator and regulator synthesis for linear time-invariant multivariable systems. The history of the Geometric Approach starts in 1969 when Basile and Marro [2] introduced and studied the basic geometric tools named by them controlled and conditioned invariant subspaces. They applied these techniques to disturbance rejection or unknown- input observability. In 1970 Wonham and Morse [18] applied a maximal controlled invariant method to decoupling and noninteracting control problems and later on Wonham's book [19] imposed the name of "(A,B)-invariant" instead of "(A,B)-controlled invariant". Basile and Marro opened new prospects to many applications (disturbance rejection, noninteraction etc.) by the robust controlled invariant and the emphasis of the duality [2]. The Marro's monograph [11] presents the various aspects of the Geometric Approach, from the fundamental concepts, the structure of the linear systems, invariant subspaces, up to applications to the regulator problem,

noninteraction, feedback and robustness etc. The LQ problem was studied in a geometric framework by Silverman, Hautus and Willems. An important series of researchers among which Anderson, Akashi, Bhattacharyya, Kucera, Malabre, Molinari, Pearson, Francis and Schumacher developed the theory and applications of the Geometric Approach. The range of the applications of the Geometric Approach was extended to various areas, including, for instance, Markovian representations (Lindquist, Picci and Ruckebusch [10]) or modeling and estimation of linear stochastic systems [9]). All these books and papers refers to the 'classical' 1D systems. In the present lecture some aspects of the Geometric Approach are extended to a class of 2D systems described by a partial differential state equation. The state space representation of these systems is characterized by five matrices: two drift matrices and , an input-state matrix , a state-output matrix and a input-output matrix . These systems represent the continuous counterpart of Attasi's 2D discrete-time model. The behavior of these 2D systems is described and their general response formula is obtained. The concepts of complete controllability and complete observability are introduced and they are characterized by means of two suitable 2D controllability and observability Gramians. In the case of time-invariant 2D some controllability and observability criteria are derived. The controllability and observability matrices are constructed (by extending the usual 1D ones). The first is used to characterize the space of the controllable states as the minimal -invariant subspace which contains the columns of the matrix B and to obtain necessary and sufficient conditions of controlability for 2D systems. An algorithm is presented which compute the minimal -invariant subspace included in , (i.e. the subspace of the controllable states of the system) and which extends the 1D algorithm from [9]. The observability Gramian and the observability matrix are employed to obtain the description of the space of non-observable states as the maximal -invariant subspace contained in and to derive some observability criteria. An algorithm is proposed which compute this invariant subspace. These invariant subspaces can be used to obtain the Kalman canonical decomposition of the state space and to reduce the system to a minimal realization.

Brief Biography of the Speaker: Prof. Valeriu Prepelita graduated from the Faculty of Mathematics-Mechanics of the University of Bucharest in 1964. He obtained Ph.D. in Mathematics at the University of Bucharest in 1974. He is currently Professor at the Faculty of Applied Sciences, the University Politehnica of Bucharest, Director of the Department Mathematics- Informatics. His research and teaching activities have covered a large area of domains such as Systems Theory and Control, Multidimensional Systems, Functions of a Complex Variables, Linear and Multilinear Algebra, Special Functions, Ordinary Differential Equations, Partial Differential Equations, Operational Calculus, Probability Theory and Stochastic Processes, Operational Research, Mathematical Programming, Mathematics of Finance. Professor Valeriu Prepelita is author of more than 110 published papers in refereed journals or conference proceedings and author or co-author of 15 books. He has participated in many national and international Grants. He is member of the Editorial Board of some journals, member in the Organizing Committee and the Scientific Committee of several international conferences, keynote lecturer or chairman of some sections of these conferences. He is a reviewer for five international journals. He received the Award for Distinguished Didactic and Scientific Activity of the Ministry of Education and Instruction of Romania.

Tutorial 1

Projective Geometry and Duality for Graphics, Games and Visualization



Professor Vaclav Skala

University of West Bohemia, Plzen
and VSB-Technical University, Ostrava
Czech Republic

URL: <http://www.VaclavSkala.eu>

Summary: The tutorial gives a practical overview of projective geometry and its applications in geometry, GPU computations and games. It will show how typical geometrical and computational problems can be solved easily if reformulated using the projective geometry. Presented algorithms are easy to understand, implement and they are robust as well.

Brief Biography of the Tutor: Prof. Vaclav Skala is a professor at the University of West Bohemia in Plzen where he established computer graphics labs and he is currently the director of the Center of Computer Graphics and Visualization (<http://Graphics.zcu.cz>). He is also a professor at the VSB Technical University in Ostrava. He is concentrated mostly on fundamental algorithms for computer graphics and visualization. In 2009, prof. Skala he became a Fellow of Eurographics Association.

Tutorial 2

Nonlinear Distortion in Wireless Transmitters



Dr. D. Budimir

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Summary: The aim of this tutorial is to provide a thorough understanding of principles, techniques and the state-of-art of the compensation of nonlinear distortion in RF and microwave circuits and transmitters for mobile and wireless applications such as such as IEEE 802.11ac, 3G, 3.5G, 3.9G (LTE) and 4G (LTE-A). During the tutorial attendees will be aware of the strengths and limitations of commercial available circuit and subsystem design tools and have a fully understanding of the problems and issues involved in their applications. At the end of the tutorial attendees will also be able to assess rigorously both the theoretical and commercial variability of using various simulators, circuit and system design tools.

Brief Biography of the Tutor: D. Budimir (M'93, SM'02) received a Ph.D. degree in Electronic and Electrical Engineering, University of Leeds, Leeds, UK. In March 1994, he joined the Department of Electronic and Electrical Engineering at Kings College London, University of London. Since January 1997, he has been with the School of Electronics and Computer Science, University of Westminster, London, UK, where is now a Reader of wireless communications and leads the Wireless Communications Research Group. His research interests include analysis and design of hybrid and monolithic microwave integrated circuits, the design of amplifiers, filters and multiplexing networks for RF, microwave and millimetre-wave applications and RF and microwave wireless system design. Dr Budimir authored or coauthored over 250 journal and conference papers in the field of RF, microwave, and millimeter-wave wireless systems and technologies. He is author of the book Generalized Filter Design by Computer Optimization (Artech House, 1998) and Software and Users Manual EPFIL-Waveguide E-plane Filter Design (Artech House, 2000), and a chapter in Encyclopaedia of RF and Microwave Engineering (Wiley, 2005). He is a Member of the EPSRC Peer Review College, a senior Member of IEEE. He is also a regular referee for IET Electronic Letters, IET Microwaves, Antennas, and Propagation, IEEE Microwave and Wireless Components Letters, IEEE Transactions on Microwave Theory and Techniques, IEEE Antennas and Wireless Propagation Letters, IEEE Transactions on Antennas and Propagation, IEEE Transactions on Circuits and Systems II and Proceedings of the IEEE, and Proceedings of the IEEE, and International Journal of RF and Microwave Computer Aided

Engineering. He is a member of several International conference Technical Program Committees. He has given more than 18 invited presentations at workshops, conferences and seminars. He has supervised 13 PhD research students as main supervisor/director of studies to a successful completion and is currently supervising 7 PhD students as the main supervisor. He has won awards for his journal papers.