Editors: Nikos Mastorakis, Metin Demiralp, N. A. Baykara

Models and Methods in Applied Sciences

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Proceedings of the International Conference on
Environment, Economics, Energy, Devices, Systems,
Communications, Computers, Mathematics

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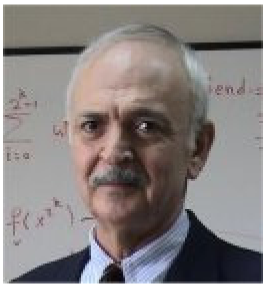
Keynote Lecture 1

Tensors or Folvecs, Folmats and Folarrs: Welcome to the Enchanted Realm of Linearity!



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Abstract: Linear algebra and its donations to us are beyond what we grasp. It presents many complete chapters although there is still room to plant new ideas, applications and facilities. It is basically constructed on one and two index arrays, namely vectors and matrices. However the power of representing almost everything in these items regarding their characters makes applied mathematics perhaps the most pleasent thing. Almost everybody tends to get help from linear algebraic tools even under storming clouds, like the nonlinearity, chaos, high multidimensionality and so on. Multidimensionality brings many difficulties to the handling of the arrays having more than two indices. A large group of applied mathematicians whose population is far beyond the estimations prefers to use the word “tensor” to cover the arrays having more than two indices. Despite its wide utilization this is not preferred by some other group of scientists including the speaker of this talk. Because “tensor” is, in its employment in continuum mechanics and physics, beyond an array which may have more than two indices. It defines a linear mapping which changes by a rule not depending on the coordinate system. This is not necessarily to be existing in all multilinear arrays. There are some other multilinear arrays which do not fulfill this condition. There are also two other words which are frequently used: “multiway array” and “multilinear array”. These might be more preferable. However there is a contradictory tendency to deal with multilinear arrays: unfolding which means to sort the elements in such a way that one or two indices suffice to represent the position in the final form after sorting. As long as a neat and unique procedure for the sorting operation is defined the reversion brings no problem and it is called folding. Unfolding and folding, they imply that the multilinear arrays can be considered either vectors’ or matrices’ folded forms and vice versa. This urges us to use the terms folvec (folded vector) and folmat (folded matrix) and (for both of them) folarr (folded array). The presentation will focus on certain issues related to these items and the linear algebra established over them. On the other hand, Singular Value Decomposition (SVD) arises at the focus as being most needed method to facilitate the use of multilinear arrays. Although this is valid in many senses SVD is not the elixir of life. It decomposes these items to rather simple components like one-rank orthonormal items. However there are some other novel approaches to orthogonally decompose these entities. High Dimensional Model Representation and recently developed Enhanced Multivariance Product Representation is amongst them. The presentation will also focus on these issues at certain level of details.

Brief Biography of the Speaker: Metin Demiralp was born in Turkey on 4 May 1948. His education from elementary school to university was entirely in Turkey. He got his BS, MS, 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 months long postdoctoral visit to the same group in 1979–1980. Metin Demiralp has more than 90 papers in well known and prestigious scientific journals, and, more than 170 contributions 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 is one of the principal members of Turkish Academy of Sciences since 1994. He is also a member of European Mathematical Society and the chief–editor of WSEAS Transactions on Computers currently. 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: Fluctuation Free 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.

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Plenary Lecture 1

Space Pruning Methods to Approximately Solve the Linear Boundary Value Problems of Ordinary Differential Equations (ODEs)

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Abstract: The most important agents in the linear boundary value problems of ordinary differential equations (ODEs) are the differential operator and the boundary conditions. The complications basically arise from the boundary conditions since they enforce the two linearly independent solutions to be in harmony by creating appropriate forward and backward evolutions. That is, the matter is to match these evolutions such that boundary conditions are satisfied in total. These types of boundary value problems can be considered in two different categories, in one of which there is no arbitrary parameter to be determined but given inhomogeneity and the question is not far beyond an operator inversion problem. Whereas the other category problems are homogeneous in unknown functions and contains an arbitrary parameter to be determined. These cases correspond to the eigenvalue problems where the unknown function takes the role of eigenfunction while the arbitrary parameter is in charge of eigenvalue. The second category problems may gain more importance in applications like in quantum mechanics where the possible energies which are in fact eigenvalues are sought and the corresponding eigenfunctions describe the nature of the wave function. One of the most important aspects of eigenfunctions is their closednesses under the action of the differential operator of the problem. In other words the image of the eigenfunction under any nonnegative number of consecutive actions of the relevant differential operator satisfies the boundary conditions as the eigenfunction itself does.
The differential operator of the boundary value problem acts on functions which can be considered lying in an appropriately defined Hilbert space. They map from this space to the same space. This space's members should satisfy the boundary conditions individually. As long as we do not know the solution of the boundary value problem we do not know the explicit structures of the eigenfunctions. However, if we would know them then each of them would conserve the property of satisfying the boundary conditions in their images under any nonnegative power of the differential operator. Therefore one can start with a set of functions in this space and then consider all the possible linear combinations satisfying the boundary conditions under the action of the differential operator. This imposes just a single condition on the linear combination coefficients. The other conditions arise from the enforcements to make the linear combination satisfying the boundary conditions under the powers of the differential operator, second, third and so on. This approach changes the basis set towards the true eigenfunction set and the infinite limit is expected to get exact match. Sufficient care must be taken about the singularity issues. The presentation will involve most important aspects as milestones of this issue.

Brief Biography of the Speaker: N. A. BAYKARA was born in Istanbul,Turkey on 29th July 1948. He received a B.Sc. degree in Chemistry from Bosphorous University in 1972. He obtained his PhD from Salford University, Greater Manchester, Lancashire,U.K. in 1977 with a thesis entitled “Studies in Self Consistent Field Molecular Orbital Theory”, Between the years 1977– 1981 and 1985–1990 he worked as a research scientist in the Applied Maths Department of The Scientific Research Council of Turkey. During the years 1981-1985 he did postdoctoral research in the Chemistry Department ofMontreal University, Quebec, Canada. Since 1990 he is employed as a Staff member of Marmara University. He is now an Associate Professor of Applied Mathematics mainly teaching Numerical Analysis courses and is involved in HDMR research and is a member of Group for Science and Methods of Computing in Informatics Institute of Istanbul Technical University. Other research interests for him are “Density Functional Theory” and “Fluctuationlessness Theorem and its Applications” which he is actually involved in. Most recent of his concerns is focused at efficient remainder calculations of Taylor expansion via Fluctuation–Free ?Integration, and Fluctuation–Free Expectation Value Dynamics.

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