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*Prof. Gabriella Bognar , University of Miskolc, Hungary*

*Prof. Leonid Perlovsky , Harvard University and the Air Force Research Lab., USA*

# **RECENT ADVANCES on APPLIED MATHEMATICS**

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*Proceedings of the AMERICAN CONFERENCE  
ON APPLIED MATHEMATICS (MATH '08)*

**Cambridge, Massachusetts, USA, March 24-26, 2008**



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A Series of Reference Books and Textbooks**

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## Preface

This book contains proceedings of the AMERICAN CONFERENCE ON APPLIED MATHEMATICS (MATH '08) which was held in Cambridge, Massachusetts, USA, March 24-26, 2008. The WSEAS Conferences on APPLIED MATHEMATICS started in Vravrona, Attica, Greece, in 2000 and the 2nd was held in Cairns, Australia 2001. Then 3rd and fourth events were proceeded Miedzyzdroje, Poland, 2002, and Malta, 2003 respectively. Since 2004, the WSEAS has been organizing 2 events on Applied Mathematics per year. In 2004 Miami, Florida, USA and Corfu, Greece Corfu. In 2005 Cancun, Mexico and Tenerife, Spain. In 2006 Istanbul, Turkey and Dallas, Texas, USA, in 2007 Dallas, Texas, USA and Cairo, Egypt. Starting in 2008, the one conference will be called AMERICAN CONFERENCE ON APPLIED MATHEMATICS and the other one simply: WSEAS CONFERENCE ON APPLIED MATHEMATICS. The Society (WSEAS) has also organized many other separate or joint conferences on Linear Algebra, Numerical Analysis, Differential Equations, Optimization, Probabilities, Statistics, Operational Research, Algorithms, Discrete Mathematics, Systems, Communications, Control etc as well as their applications and their interaction with other areas of Engineering and Applied Science. The relevant titles could be retrieved from the web site: [www.worldses.org/history.htm](http://www.worldses.org/history.htm)

We thank the University of Harvard (Harvard Graduate School of Education) for giving us the Gutman Conference Center to run the AMERICAN CONFERENCE ON APPLIED MATHEMATICS (MATH '08). This conference aims to disseminate the latest research and applications in the afore mentioned fields. The friendliness and openness of the WSEAS conferences, adds to their ability to grow by constantly attracting young researchers. The WSEAS Conferences attract a large number of well-established and leading researchers in various areas of Science and Engineering as you can see from <http://www.wseas.org/reports>. Your feedback encourages the society to go ahead as you can see in <http://www.worldses.org/feedback.htm>

We thank also our editors: Prof. Charles Long (University of Wisconsin-Stevens Point (UWSP), USA), Prof. Siavash H. Sohrab (Northwestern University, USA), Prof. Gabriella Bognar (University of Miskolc, Hungary), Prof. Leonid Perlovsky (Harvard University and the Air Force Research Lab., USA), our Plenary Speakers and of course the Reviewers that made the enormous and difficult task of the review approving only 71 papers from a total number of 197 submitted papers. For example, several authors sent three times their papers in order to satisfy all the reviewers' comments. The names of the reviewers can be found on <http://www.worldses.org/review/index.html>

The contents of this Book are also published in the CD-ROM Proceedings of the Conference. Both will be sent to the WSEAS collaborating indices after the conference: [www.worldses.org/indexes](http://www.worldses.org/indexes)

In addition, papers of this book are permanently available to all the scientific community via the WSEAS E-Library.

Expanded and enhanced versions of papers published in these conference proceedings are also going to be considered for possible publication in one of the WSEAS journals that participate in the major International Scientific Indices (Elsevier, Scopus, EI, ACM, Compendex, INSPEC, CSA .... see: [www.worldses.org/indexes](http://www.worldses.org/indexes)) these papers must be of high-quality (break-through work) and a new round of a very strict review will follow. (No additional fee will be required for the publication of the extended version in a journal). WSEAS has also collaboration with several other international publishers and all these excellent papers of this volume could be further improved, could be extended and could be enhanced for possible additional evaluation in one of the editions of these international publishers.

Finally, we cordially thank all the people of WSEAS for their efforts to maintain the high scientific level of conferences, proceedings and journals.

We are sure that this volume will be source of knowledge and inspiration for other academicians, scholars, advisors and industrial practitioners and will be considered as one more brilliant edition of the WSEAS related with a brilliant conference in the university of Harvard.

## Proceedings of the AMERICAN CONFERENCE ON APPLIED MATHEMATICS (MATH '08)

<b>Plenary Lecture I: The Convolution and Impulse Response Scandals</b>	15
<i>Irwin W. Sandberg</i>	
<b>Plenary Lecture II: Switching of Predation on Prey Species in the Presence of Predator Interference</b>	16
<i>Balswaroop Bhatt</i>	
<b>Plenary Lecture III: Spectral Structure of the Equilateral Triangle</b>	17
<i>Brian J. McCartin</i>	
<b>Plenary Lecture IV: Path-Based Modeling: A Generalized Framework for Formulating Combinatorial Optimization Problems as Linear Programs</b>	18
<i>Moustapha Diaby</i>	
<b>Plenary Lecture V: The Power of Two, Speed of Light, Force and Energy and the Universal Gas Constant</b>	19
<i>Charles A. Long &amp; Siavash H. Sohrab</i>	
<b>Plenary Lecture VI: Intelligent Pattern Recognition and Biometrics</b>	20
<i>Patrick Wang</i>	
<b>Plenary Lecture VII: The spectral problems of some nonlinear differential equations</b>	21
<i>Gabriella Bognar</i>	
<b>Plenary Lecture VIII: Toward Physics of the Mind: Concepts, Emotions, Consciousness, and Symbols</b>	22
<i>Leonid Perlovsky</i>	
<b>Geometric Applications of Bivariate Q-Bernstein and Q-Orthogonal Polynomials</b>	25
<i>Plamen Simeonov and Vasilis Zafiris</i>	
<b>Optimal Calculation of Partial Transmission Ratios For Four-Step Helical Gearboxes with First and Third Step Double Gear-Sets for Minimal Gearbox Length</b>	29
<i>Vu Ngoc Pi</i>	
<b>Finsler Optimal Control and Geometric Dynamics</b>	33
<i>Constantin Udriste</i>	
<b>A General Scheme of Extracting the Optimum Pattern Nulls For Monopulse Array Antennas with Arbitrary Sidelobe Levels</b>	39

*Keum-Sook Ha, Eui-Joon Park*

**Multivariate Quadratic Trapdoor Functions Based on Multivariate Quadratic Quasigroups** **44**

*Danilo Gligoroski, Smile Markovski And Svein Johan Knapskog*

**An Application of Stochastic Analysis on Beam Bending Problem** **50**

*Mladen Mestrovic*

**Reduced Models for Solving Particle Beams and Plasma Physics Problems** **54**

*Franck Assous*

**Mathematical Models of Persuasion** **60**

*J. Curtis F. Smith*

**Algebraic Construction of Exact Difference Equations from Symmetry of Functions** **66**

*Toshiaki Itoh*

**A Geometric Programming Model of the Lot-Scheduling Problem with Investments in Setup Reductions And Process Improvements** **72**

*Jose M. Cruz, Moustapha Diaby, Aaron L.Nsakanda*

**Coping with Revenue Recognition in the Loyalty Reward Programs Industry: A Stochastic Modeling Approach** **79**

*Moustapha Diaby, Aaron L. Nsakanda*

**The Power of Two, Speed of Light, Force and Energy and the Universal Gas Constant** **87**

*Charles A. Long, Siavash H. Sohrab*

**Performance of Complete and Nearly Complete Binary Search Trees.** **98**

*Ahmed Tarek*

**Multi-Key Binary Search and the Related Performance** **104**

*Ahmed Tarek*

**Testing Validity and Reliability of Classical School of Strategic Management** **110**

*Lara Jelenc*

**Mixed P-Z Model for the Analyze of the Switching Power Circuits with Periodic PWM** **115**

*Jiri Klima*

**Loan Payment Prediction Using Rough Sets** **124**

*Bahaddin Ruzgar, Nursel Selver Ruzgar*

**Computational Complexity Simplified** **130**

*Ahmed Tarek*



<b>Mathematical Tool of Discrete Dynamic Modeling of Complex Systems in Control Loop</b>	<b>136</b>
<i>Armen Bagdasaryan</i>	
<b>A Lyapunov Shortest-Path Characterization for Markov Decision Processes</b>	<b>143</b>
<i>Julio Clempner, Jesus Medel</i>	
<b>Ecological Optimization Using Harmony Search</b>	<b>148</b>
<i>Zong Woo Geem, Justin C. Williams</i>	
<b>Travelling Wave Solutions for a CBS Equation in 2+1 Dimensions</b>	<b>153</b>
<i>Maria Luz Gandarias, Maria Santos Bruzon</i>	
<b>New Solutions for a Generalized Benjamin--Bona--Mahony--Burgers Equation</b>	<b>159</b>
<i>Maria S. Bruzon And Maria L. Gandarias</i>	
<b>Analyzing Sliding Bifurcations on Discontinuity Boundary of Filippov Systems</b>	<b>165</b>
<i>Iván Arango, John Alexander Taborda</i>	
<b>An Overview of Conditionals and Biconditionals in Probability</b>	<b>171</b>
<i>Greene, Nataniel</i>	
<b>Stochastic Optimization with Mean Absolute Negative Deviation Measure for Portfolio Selection Problem</b>	<b>178</b>
<i>Ibrahim Khilpah., Kamil Anton. Abdulbasah. &amp; Mustafa Adli</i>	
<b>Parallel Algorithm for Codebook Generation with Multi-Step Approach and Hierarchical Clustering</b>	<b>185</b>
<i>Akiyoshi Wakatani</i>	
<b>Novel Diversity Combining in OFDM-Based MIMO Systems</b>	<b>189</b>
<i>Jean-Pierre Dubois, Omar Abdul-Latif</i>	
<b>Spectral Structure of the Equilateral Triangle I: Lame's Formulas</b>	<b>195</b>
<i>Brian J. McCartin</i>	
<b>Spectral Structure of the Equilateral Triangle II: Beyond Lame's Formulas</b>	<b>201</b>
<i>Brian J. McCartin</i>	
<b>Poisson Modulated Stochastic Model for Partially Developed Multi-Look Speckle</b>	<b>209</b>
<i>Jean-Pierre Dubois</i>	
<b>Double-Diffusive Convection for a Non-Newtonian Fluid Flow Past a Permeable Surface Embedded in a Porous Medium with Uniform Heat and Mass Fluxes</b>	<b>214</b>
<i>Ali J. Chamkha</i>	
<b>A Model of Communication Technology Education and Its Application in A Primary School-- Take PHS Phones as Example</b>	<b>220</b>

*Rong-Jyue Fang, Hung -Jen Yang, Hua- Lin Tsaii, Chi -Jen Lee,*

**The Structure of Executive Situations and Knowledge Management of the Grade 1-9 Curriculum in The Elementary School** 225

*Wen-Jiuh Chiang Rong-Jyue Fang, Zhen-Gang Chen, Hua- Lin Tsai,*

**A Model of Technological Course of Using Information Technology** 232

*Rong-Jyue Fang, Hung Jen Yang, Hua Lin Tsai, Chi Jen Lee, Tien-Sheng Tsai, Dai-Hua Li*

**A Model of the Digital Tool Promoting the Teacher's Instructional Innovation** 237

*Rong-Jyue Fang, Hung Jen Yang, Hua Lin Tsai, Chi Jen Lee, ,Dai-Hua Li*

**Developing a Model of in-Service Training by Using Multinomial Logistic Regression** 241

*Hung-Jen Yang, Jui-Chen Yu and Hsieh-Hua Yang*

**Fourier Series of Orthogonal Polynomials** 247

*Nataniel Greene*

**Intelligent Supervisory Control of Continuous Processes Exposed To Faults: A Practical Approach** 252

*Carlos Parra Ortega, Eliézer Colina Morles, Edgar Chacón Ramírez*

**Algebraic Structures and Integrability of Vector Fields On  $\mathbb{R}^3$**  259

*Stanislaw Kasperczuk*

**On the Dispersion of a Solute in a Casson Fluid Flow in an Annulus with Boundary Absorption** 265

*Nagarani Ponakala, Sarojamma G., Girija Jayaraman*

**Improved Newton Raphson Method – An Effective Tool in Solving Flow-Mechanic-Chemistry Equations of Co2 Storage in Saline Aquifers** 274

*Shunping Liu, Bjorn Kvamme*

**Wavelet Based Speech Enhancement Technique Using Median Function Thresholding** 283

*A.K.Sinha, Shikhar Kanti Dutta, Budhaditya Dev, Jaydipta, Ranjana Kumari*

**A Generalized Data Meta-Model for Production Companies** 287

*César Bravo, Jose Aguilar, Addison Ríos-Bolivar, Joseph Aguilar-Martin, Francklin Rivas-Echeverría*

**On a Parabolic Inclusion with Integral Boundary Conditions** 293

*Abdelkader Boucherif*

**Calculating the sample size of multivariate populations: Norms of representation** 301

*Constantinos Tsiantis*

**Periodic and Antiperiodic Eigenvalues for Quasilinear Differential Equations** 307

*Gabriella Bogнар*

<b>Reliability Score Based Multimodal Fusion for Biometric Person Authentication</b>	<b>313</b>
<i>Girija Chetty, Michael Wagner</i>	
<b>Taxonomy of Nominal Type Histogram Distance Measures</b>	<b>325</b>
<i>Sung-Hyuk Cha</i>	
<b>Developing a Model Of Online Learning-Technology Acceptance Model (TAM)</b>	<b>331</b>
<i>Rong-Jyue Fang, Chung-Ping Lee, Shi-Jer Lou ,Hua-Lin Tsai, Hung-Jen Yang</i>	
<b>Using a Blog to Build Mathematical Knowledge at the Tertiary Level</b>	<b>337</b>
<i>Fariel Mohan, B.S. Bhatt</i>	
<b>Fuzzy Systems with Recurrent Rules in Population and Medical Models</b>	<b>343</b>
<i>Horia-Nicolai L. Teodorescu</i>	
<b>On the K-Subgraphs of the Generalized N-Cubes</b>	<b>349</b>
<i>Geoffrey A. Solano, Jaime Di Caro</i>	
<b>Introducing an Explicit 2D Matrix free Galerkin Finite Volume Method for Analyzing Structural Dynamics on Unstructured Mesh of Linear Triangular Elements</b>	<b>355</b>
<i>Saeed Reza Sabbagh Yazdi, Mehdi Esmaeili, Nikos E. Mastorakis</i>	
<b>Probability of Collisions in Soft input Decryption</b>	<b>362</b>
<i>Natasa Zivic And Christoph Ruland</i>	
<b>Predicting Bankruptcies Using Rough Set Approach: The Case of Turkish Banks</b>	<b>367</b>
<i>Nursel Selver Ruzgar, Fahri Unsal, Bahadtin Ruzgar</i>	
<b>Simulation of Self Aeration at Steep Chute Spillway Flow Using VOF Technique in a 3D Finite Volume Software</b>	<b>373</b>
<i>Saeed-Reza Sabbagh-Yazdi, Fatemeh Rostami, Nikos E. Mastorakis</i>	
<b>Dynamic Matrix Controller Based on Sliding Mode Control</b>	<b>379</b>
<i>Oscar Camacho, Luis Valverde, Edinzo Iglesias, Franklin Rivas</i>	
<b>Optimal Determination of Partial Transmission Ratios of Three-Step Helical Gearboxes with First and Third-Step Double Gear-Sets for Minimal Mass Of Gears</b>	<b>385</b>
<i>Vu Ngoc Pi</i>	
<b>Numerical Simulations of a Second-Order Fluid with Normal Stress Coefficients Depending on the Shear Rate</b>	<b>389</b>
<i>Fernando Carapau</i>	
<b>The Review of the Role of Business intelligence in Business Engineering</b>	<b>396</b>
<i>Katarina Åeurko, Mladen Varga</i>	

<b>Short-Term Streamflow Forecasting: ARIMA Vs Neural Networks</b>	<b>402</b>
<i>E. Pita, J. Frausto-Solis, J. Lagunas</i>	
<b>A Wavelet-Based Method for Overcoming the Gibbs Phenomenon</b>	<b>408</b>
<i>Nataniel Greene</i>	
<b>On the Ermanno-Bernoulli and Quasi-Ermanno-Bernoulli Constants for Linearizing Dynamical Systems</b>	<b>413</b>
<i>Festus Irimisose Arunaye, H. White</i>	
<b>A Novel Fingerprint Matching and Classification Schema Based on Nested Convex Polygons</b>	<b>419</b>
<i>Hamzeh Khazaei, Ali Mohades</i>	
<b>Adaptive Cdma/Cd: An Improved Mac Protocol</b>	<b>427</b>
<i>S.Silakari, Piyush Kumar Shukla ,Ujjwal Nigam</i>	
<b>Switching Code Data Compression Technique Using an Adaptive Huffman Coding</b>	<b>431</b>
<i>Rajesh Kumar Deharia, Mitesh Bargadia ,Sushil Kumar,Piyush Kumar Shukla</i>	
<b>A Pioneer Compression Technique for Database</b>	<b>437</b>
<i>Rajesh Kumar Deharia, Mitesh Bargadia ,Sushul Kumar,Piyush Kumar Shukla</i>	
<b>The 2-Dimensional Probabilistic Bin Packing Problem : An average case analysis of the FBS algorithm</b>	<b>449</b>
<i>Leila Horchani and Monia Bellalouna</i>	
<b>Comparision of constraint design of fir filter on complex error function and on magnitude and phase independently</b>	<b>454</b>
<i>Raghvendra Kumar, Lillie Dewan</i>	

## Plenary Lecture I

### The Convolution and Impulse Response Scandals



**Professor Irwin W. Sandberg**

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The University of Texas at Austin  
1 University Station C0803  
Austin, Texas 78712 - 0240  
USA

**Abstract:** It is a widely-held belief that the main textbook conclusions concerning continuous-time linear systems obtained using Dirac delta-function arguments can be shown to be valid using the mathematical theory of distributions. But this belief is unwarranted. For example, in a recent study of multidimensional input-output maps representing linear shift-invariant systems that take a set of continuous-space signals into itself, it was shown that the family contains maps – even causal continuous maps – whose impulse response is the zero function, but which take certain inputs into nonzero outputs. In this connection, we give recent results concerning the representation of the input-output map associated with the members of a certain important large family of multidimensional linear systems. We also give necessary and sufficient conditions under which the representation can be written as a convolution, and we relate this to the concepts of an impulse response and a q-response limit, and to the flawed concept of the Dirac function.

**Brief Biography of the Speaker:** Irwin W. Sandberg received the B.E.E., M.E.E., and D.E.E. degrees from the Polytechnic Institute of Brooklyn (now the Polytechnic University) in 1955, 1956, and 1958, respectively (Westinghouse Fellow 1956, Bell Laboratories Fellow 1957 and 1958). He is presently an emeritus Professor of Electrical and Computer Engineering at the University of Texas at Austin, where he holds the Cockrell Family Regents Chair Emeritus in Engineering, No. 1. From 1958 to 1986, he was with Bell Laboratories, Murray Hill, New Jersey, as a Member of Technical Staff in the Communication Sciences Research Division, and, from 1967 to 1972, as Head of the Systems Theory Research Department. He has been concerned with the analysis of radar systems for military defense, with synthesis and analysis of linear networks, with several studies of qualitative properties of nonlinear systems (with emphasis on the theory of nonlinear networks as well as on the introduction and development of input-output stability theory), and with some problems in communication theory and numerical analysis. His more recent interests include studies of the approximation and signal-processing capabilities of dynamic nonlinear networks. Dr. Sandberg received the first Technical Achievement Award of the IEEE Circuits and Systems Society. He is a Fellow of the American Association for the Advancement of Science, a Life Fellow of the IEEE, an IEEE Centennial Medalist, an IEEE Millennial Medalist, a Circuits and Systems Society Golden Jubilee Medal recipient, a former Circuits and Systems Society Distinguished Lecturer, an Outstanding Alumnus of Polytechnic University, a former Vice Chairman of the IEEE Group on Circuit Theory, a former Guest Editor of the IEEE TRANSACTIONS ON CIRCUIT THEORY Special Issue on Active and Digital Networks, and a former Guest Editor of the IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS Darlington Memorial Issue. He has published extensively and has been an advisor to American Men and Women of Science. He is listed in Who's Who in America, and holds nine patents. He has received outstanding paper awards, an ISI Press Classic Paper Citation, and a Bell Laboratories Distinguished Staff Award. He is a member of Eta Kappa Nu, Sigma Xi, Tau Beta Pi, the Academy of Medicine, Engineering and Science of Texas, and the National Academy of Engineering.

## Plenary Lecture II

### Switching of Predation on Prey Species in the Presence of Predator Interference



**Professor Balswaroop Bhatt**

Department of Mathematics and Computer Science,  
The University of the West Indies,  
St. Augustine, Trinidad and Tobago, W.I.

**Abstract:** The present study deals with a prey- predator model where the prey can freely move within two habitats and the predator can switch to the habitat with most abundant species. The predation has been studied in the presence of predator interference. The stability analysis has been carried out for non zero equilibrium values. Conversion rate of the prey to predator has been taken as a bifurcation parameter and for select data sets, bifurcation points have been found. Interestingly, contrary to the earlier work, all the three types of situations, namely – no bifurcation, single and multiple bifurcations exist.

**Brief Biography of the Speaker:** Prof. B. Bhatt received the B.Sc.(1969), M.Sc.(1971)and the Ph.D.( Jan. 1976) in Fluid Dynamics from University of Rajasthan, Jaipur, India and a Fellow of the Institute of Mathematics and its Application, UK [FIMA]. Prof. Bhatt has been the Head of Mathematics and Computer Science Department in the University of the West Indies, St. Augustine, Trinidad during June 2002- July 2005. His research interest is in Fluid Dynamics( Newtonian and non- Newtonian fluid flows, MHD and flow through porous media) and Bio- Mathematics( epidemic models and prey- predator models). He has published 68 papers in leading journals of the world [ e.g. JFM, QJMAM, Physics of Fluids, J. Appl. Phys., ZAMM, Rehol. Acta, J. Theor. Biology, J. Physical Soc. Japan, Wear, Appl. Sci. Res., J. de Mec., Proc. Ind. Acad. Sc., Indian J. Pure & Appl. Maths.]. He has received the award of ACU Academic Staff Fellowship tenable at DAMTP, Cambridge, U.K.(during 1986-87), a Fellowship of British Petroleum of Trinidad and Tobago tenable at University College London and DAMTP, University of Cambridge, U.K.(during October - December 2004). He has been reviewer of Applied Mechanics Reviews, Zentralblatt fur Mathematik. He is on the editorial board of Matematicas Enseanza Universitaria. He has refereed papers for Indian Journal of Pure and Applied Mathematics, Indian Journal of Mathematics, Canadian journal of Physics,Journal of Lubrication Technology, Applied Mathematical Letters , J. Eng. Maths. and J. Porous Media.

## Plenary Lecture III

### Spectral Structure of the Equilateral Triangle



**Professor Brian J. McCartin**  
Department of Mathematics,  
Kettering University,  
Flint, Michigan USA

**Abstract:** Lamé's formulas for the eigenvalues and eigenfunctions of the Laplacian on an equilateral triangle with Dirichlet and Neumann boundary conditions will be reviewed and then extended to the Robin boundary condition. The eigenfunctions will be shown to form a complete orthonormal system. Various properties of the spectrum and modal functions will be explored.

**Brief Biography of the Speaker:** Brian McCartin received his B.S. (with Highest Distinction) and M.S. in Mathematics from University of Rhode Island, and his Ph.D. in Applied Mathematics from NYU's Courant Institute of Mathematical Sciences. He also holds the degree of Bachelor of Music (Summa Cum Laude) from the Hartt School of Music at the University of Hartford. In 2000, he was the recipient of Kettering University's Outstanding Researcher Award and received their Outstanding Teaching Award in 2001 and again in 2006. He was the 2004 recipient of the Award for Distinguished College or University Teaching of Mathematics from the Michigan Section of the Mathematical Association of America. Prior to joining the Kettering University faculty in 1993, he was Senior Research Mathematician for United Technologies Corporation and chairman of Computer Science at Rensselaer Polytechnic Institute's Hartford, CT campus. He serves on the Editorial Board of the international journal Applied Mathematical Sciences and is a Fellow of the Electromagnetics Academy.

## Plenary Lecture IV

### Path-Based Modeling: A Generalized Framework for Formulating Combinatorial Optimization Problems as Linear Programs



**Professor Moustapha Diaby**  
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**Abstract:** The subject of combinatorial optimization spans several fields of study, and is applicable in a large number of practical contexts. The great difficulty involved in solving combinatorial optimization problems has to do, mostly, with their discrete nature. The general idea of most of the theoretical developments dealing with these problems over the past several decades has been to tackle this discreteness directly, by enforcing it through integrality requirement constraints. As a result of this “quest for integrality,” the optimal resolution of these problems has typically required some enumeration of the solutions, and the goal of the theoretical developments in general has consisted of providing tools that can be used to craft “tailor-made” procedures that exploit, to the extent possible, the particular characteristics of the problem at hand. In this talk we will define the notion of “Path-Based Modeling” and discuss its use in formulating some of the well-known NP-Complete combinatorial optimization problems as linear programs. Unlike other approaches, the focus in this approach is on enforcing the convexity of a complete feasible solution with respect to the objects being modeled, rather than attempting to enforce the integrality of individual variables. The approach will be illustrated using the Set Partitioning Problem as an example. Some reflections on the computational complexity paradigm will also be discussed.

**Brief Biography of the Speaker:** Moustapha Diaby is Associate Professor of Production and Operations Management at the School of Business Administration, University of Connecticut. He received a Ph.D. degree in Management Science/Operations Research, M.S. degree in Industrial Engineering, and B.S. degree in Chemical Engineering from the State University of New York at Buffalo. His teaching and research interests are in the areas of mathematical programming, production planning and control, manufacturing systems modeling and analysis, and supply chain and logistics management. His publications have appeared in many of the top-tier journals in these areas. He has served/currently serves as a reviewer and/or ad-hoc editorial team member for many of these journals also, and for government agencies (such as NSF for example). He has also held national-level offices within the professional societies and chaired several national-level events and activities.



## Plenary Lecture V

### The Power of Two, Speed of Light, Force and Energy and the Universal Gas Constant

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**Abstract:** The application of  $c^2$  in relation to mass and energy had an interesting history. The Pythagorean theorem is involved. Even in basic Newtonian physics the studies of retarded speed (in collisions) suggest multiplication of sums. When  $p = mv$ , and  $v = c$ , the term  $m c^2$  appears, which was one relation of momentum written by Poincaré. He also related mass and the speed of light to a complementary electromagnetic force. De Pretto, by means of no offered calculations, proposed energy equal to the product of mass and the speed of light squared. This was precisely the famous equation. He applied it hypothetically into a supposed material ether. He certainly considered mass as comprised of a great amount of latent heat, and mentioned how small the particles of ethereal matter must be to have escaped notice. He implied matter was miniscule in relation to its latent energy. Einstein also recognized the compact and enormous energy in mass, writing out the famous equation thereby establishing its popularity. By algebraic manipulations of sums and products, even common denominators, the square of light speed  $c$  became commonplace in physics, never related to the Euclidian concept, although it could be and could have been. A possible way that De Pretto could have arrived at his number 8338 is suggested and his number is identified as the modified universal gas constant  $R = 8338$  Joules/(kgmol-K).

## Plenary Lecture VI

### Intelligent Pattern Recognition and Biometrics



**Professor Patrick Wang**

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**Abstract:** This tutorial deals with advanced concepts of Artificial Intelligence (AI) and Pattern Recognition (PR), and their applications to solving real life problems including biometrics applications. It basically covers the following topics: (1) Overview of Pattern Recognition (PR), (2) Overview of Artificial Intelligence (AI), (3) The Relation Between PR and AI, (4) Analysis and Learning: Pattern Recognition Concept : Foundation and theories, (5) Importance of Ambiguity, and its Applications: Theory and applications, (6) An Overall Interactive Intelligent Pattern Recognition (IPR) System, (7) Concepts of Syntax, Semantics, and Pragmatics: Theories and Applications, (8) Importance of Ambiguity, and its Applications: Theory and Applications, (9) How it works: IPR and Applications to Solving Real Life Problems including Biometrics and Face Recognition, (10) Some More Illustrations, Discussions and Future Directions.

**Brief Biography of the Speaker:** Prof. Patrick Wang, PhD. IAPR Fellow, is Tenured Full Professor, Northeastern University, USA, iCORE (Informatics Circle of Research Excellence) Visiting Professor, University of Calgary, Canada, Otto-Von-Guericke Distinguished Guest Professor, Magdeburg University, Germany, as well as honorary advisory professor of several key universities in China, including Sichuan University, Xiamen University, East China Normal University, Shanghai, and Guangxi Normal University, Guilin. Dr. Wang has published over 21 books, 120 technical papers, 3 USA/European Patents, in PR/AI/Imaging, and is currently Editor-in-Chief of IJPRAI (International Journal of Pattern Recognition and Artificial Intelligence) , and Book Series of MPAI, WSP. In addition to his technical interests, Dr. Wang also published a prose book, “Harvard Meditation Melody” and many articles and poems regarding Du Fu and Li Bai’s poems, Beethoven, Brahms, Mozart and Tchaikovsky’s symphonies, and Bizet, Verdi, Puccini and Rossini’s operas.

## Plenary Lecture VII

### The spectral problems of some nonlinear differential equations



**Professor Gabriella Bognar**

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**Abstract:** The present study deals with eigenvalue problems of nonlinear differential equations with  $p$ -Laplacian. If  $p=1$ , these problems reduce to linear eigenvalue problems which are well understood and treated in many classical books. For the nonlinear differential equations we consider the eigenvalues and eigenfunctions concerning different domains, some isoperimetric problems and some properties of the periodic solutions. Our aim is to present results on the nonlinear differential equations involving  $p$ -Laplacian. We show similarities in the qualitative behavior of solutions of the linear and nonlinear problems, and we also point out phenomena where properties of solutions considerably differ.

**Brief Biography of the Speaker:** Gabriella Bognar received the M.Sc. in Mechanical Engineering from University of Miskolc, Miskolc, Hungary, the Ph.D. in Mathematics and 'Candidate' of Math. Sciences from the Hungarian Academy of Sciences. She is presently a Professor at the Department of Analysis, University of Miskolc, Hungary. Her teaching and research interests are in the areas of ordinary and partial differential equations, analysis, and complex functions. Gabriella Bognar has published 5 books, and over 70 papers. She has been reviewer of Mathematical Reviews. She is on the editorial board of Mathematical Notes, Miskolc.

## Plenary Lecture VIII

### Toward Physics of the Mind: Concepts, Emotions, Consciousness, and Symbols



**Professor Leonid Perlovsky**

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**Abstract:** Recent advances in mathematics, cognitive science, and neurobiology are bringing us close to physical theory of the mind. We can describe mathematically concepts, emotions, instincts, imaginations, intuitions. All of these are inseparable from perception and cognition. These, in turn, are related to inverse scattering: we infer properties of the world from scattered light and sound waves. I first explain a scheme for reducing combinatorial complexity often encountered in the past attempts at designing “intelligent systems,” and then briefly discuss engineering applications (data mining, fusion, financial predictions, Internet search engines); and present results demonstrating orders of magnitude improvement in classical detection and tracking in noise. The last part of the talk moves to future research directions: roles of the beautiful, music, sublime in the mind, cognition, consciousness, and evolution. The current “East vs. West” confrontation turns out related to differences in grammar between English and Arabic. What are the mechanisms of language and cultural evolution? Presented mathematical theory is related to the knowledge instinct, which drives the mind to understand the world. This instinct is even more important than sex or food. This connects computers and the mind, the high and the mundane.

**Brief Biography of the Speaker:** Dr. Leonid Perlovsky, Visiting Scholar at Harvard, Principal Research Physicist and Technical Advisor at the Air Force Research Lab. He leads Semantic Web project and other research programs. From 1985 to 1999, as Chief Scientist at Nichols Research, a \$0.5 B high-tech organization, he led the corporate research in intelligent systems, neural networks, and sensor fusion. He served as professor at Novosibirsk and New York Universities; participated as a principal in startups developing tools for text understanding, biotechnology, and financial predictions. His company predicted the market crash following 9/11 a week before the event, detecting activities of Al Qaeda traders, and later helped SEC looking for perpetrators. He delivered invited keynote plenary talks and tutorial lectures around the globe, published more than 280 papers, 10 book chapters, a monograph “Neural Networks and Intellect,” Oxford University Press, 2000 (currently in the 3rd printing) and 2 books with Springer in 2007. Dr. Perlovsky organizes conferences on Computational Intelligence, leads IEEE NNTC Task Force on “The Mind and Brain,” serves on the Board of Governors of the International Neural Network Society 2008-2011, as Associate Editor for IEEE Transactions for Neural Networks, Editor-at-Large for “Natural Computations,” and Editor-in-Chief for “Physics of Life Reviews.” He received several National and International Awards, including Gabor Award, the highest engineering award from International Neural Network Society 2007; and McLucas Award from the USAF 2007 (the highest AF scientific award).

## ATHOR INDEX

Abdul-Latif, O.	189	Horchani, L.	449
Æurko, K.	396	Ibrahim, K.	178
Aguilar, J.	287	Iglesias, E.	379
Aguilar-Martin, J.	287	Itoh, T.	66
Arango, I.	165	Jayaraman, G.	265
Arunaye, F.I.	413	Jaydipta	283
Assous, F.	54	Jelenc, L.	110
Bagdasaryan, A.	136	Kamil, A.A.	178
Bargadia, M.	431, 437	Kasperczuk, S.	259
Bellalouna, M.	449	Khazaei, H.	419
Bhatt, B.S.	337	Klima, J.	115
Bognar, G.	307	Knapskog, S.J.	44
Boucherif, A.	293	Kumar, R.	454
Bravo, C.	287	Kumar, S.	431, 437
Bruzon, M.S.	153, 159	Kumari, R.	283
Camacho, O.	379	Kvamme, B.	274
Carapau, F.	389	Lagunas, J.	402
Caro, J.D.	349	Lee, C.J.	220, 232, 237
Cha, S.H.	325	Lee, C.P.	331
Chamkha, A.J.	214	Li, D.H.	232, 237
Chen, Z.G.	225	Liu, S.	274
Chetty, G.	313	Long, C.A.	87
Chiang, W.J.	225	Lou, S.J.	331
Clempner, J.	143	Markovski, S.	44
Cruz, J.M.	72	Mastorakis, N.E.	355, 373
Curtis, J.	60	Mccartin, B.J.	195, 201
Deharia, R.K.	431, 437	Medel, J.	143
Dev, B.	283	Mestrovic, M.	50
Dewan, L.	454	Mohades, A.	419
Diaby, M.	72, 79	Mohan, F.	337
Dubois, J.P.	189, 209	Morles, E.C.	252
Dutta, S.K.	283	Mustafa, A.	178
Esmaeili, M.	355	Nigam, U.	427
Fang, R.J.	220, 225, 232, 237, 331	Nsakanda, A.L.	72
Frausto-Solis, J.	402	Nsakanda, A.L.	79
Gandarias, M.L.	153	Ortega, C.P.	252
Geem, Z.W.	148	Park, E.J.	39
Gligoroski, D.	44	Pi, V.N.	29, 385
Greene, N.	247, 408, 171	Pita, E.	402
Ha, K.S.	39	Ponakala, N.	265

Ramírez, E.C.	252	Tarek, A.	98, 104, 130
Ríos-Bolivar, A.	287	Teodorescu, H.N.L.	343
Rivas, F.	379	Tsai, H.L.	225, 220, 232, 237, 331
Rivas-Echeverría, F.	287	Tsiantis, C.	301
Rostami, F.	373	Udriste, C.	33
Ruland, C.	362	Unsal, F.	367
Ruzgar, B.	124, 367	Valverde, L.	379
Ruzgar, N.S.	124, 367	Varga, M.	396
Sabbagh-Yazdi, S.R.	373	Wagner, M.	313
Sarojamma, G.	265	Wakatani, A.	185
Shukla, P.K.	427, 431, 437	White, H.	413
Silakari, S.	427	Williams, J.C.	148
Simeonov, P.	25	Yang, H.H.	241
Sinha, A.K.	283	Yang, H.J.	220, 232, 237, 241, 331
Smith, F.	60	Yazdi, S.R.S.	355
Sohrab, S.H.	87	Yu, J.C.	241
Solano, G.A.	349	Zafiridis, V.	25
Taborda, J.A.	165	Zivic, N.	362

