Editors:
Prof. Cornelia A. Bulucea, University of Craiova, Romania
Prof. Valeri Mladenov, Technical University of Sofia, Bulgaria
Prof. Emil Pop, University of Petrosani, Romania
Prof. Monica Leba, University of Petrosani, Romania
Prof. Nikos Mastorakis, Technical University of Sofia, Bulgaria

Recent Advances in Applied Mathematics

# Recent Advances in Applied Mathematics

**Proceedings of the 14th WSEAS International Conference on APPLIED MATHEMATICS (MATH '09)**

**Puerto De La Cruz, Tenerife, Canary Islands, Spain, December 14-16, 2009**

**Mathematics and Computers in Science and Engineering**
**A Series of Reference Books and Textbooks**

**ISBN: 978-960-474-138-0**
**ISSN: 1790-2769**

**Published by WSEAS Press**
**www.wseas.org**


# RECENT ADVANCES in APPLIED MATHEMATICS

**Proceedings of the 14th WSEAS International Conference on APPLIED MATHEMATICS (MATH '09)**

**Puerto De La Cruz, Tenerife, Canary Islands, Spain**
**December 14-16, 2009**

Mathematics and Computers in Science and Engineering
A Series of Reference Books and Textbooks

Published by WSEAS Press
www.wseas.org

ISSN: 1790-2769
ISBN: 978-960-474-138-0

# RECENT ADVANCES in APPLIED MATHEMATICS

## Proceedings of the 14th WSEAS International Conference on APPLIED MATHEMATICS (MATH '09)

## Puerto De La Cruz, Tenerife, Canary Islands, Spain
## December 14-16, 2009

Mathematics and Computers in Science and Engineering
A Series of Reference Books and Textbooks

Published by WSEAS Press
www.wseas.org



All papers of the present volume were peer reviewed by two independent reviewers. Acceptance was granted when both reviewers' recommendations were positive.
See also: http://www.worldses.org/review/index.html

ISSN: 1790-2769
ISBN: 978-960-474-138-0


World Scientific and Engineering Academy and Society

# RECENT ADVANCES in APPLIED MATHEMATICS

**Proceedings of the 14th WSEAS International Conference on APPLIED MATHEMATICS (MATH '09)**

**Puerto De La Cruz, Tenerife, Canary Islands, Spain**
**December 14-16, 2009**

**Preface**

This year the 14th WSEAS International Conference on APPLIED MATHEMATICS (MATH '09) was held at Puerto De La Cruz, Tenerife, Canary Islands, Spain, December 14-16, 2009. The conference remains faithful to its original idea of providing a platform to discuss linear algebra, numerical analysis, differential equations, probabilities, statistics, operational research, optimization, algorithms, discrete mathematics 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

# Table of Contents

## Plenary Lecture 1

# Sensitivity and Stability of Singular Linear Systems

**Professor M. Isabel Garcia-Planas**
Departament de Matematica Aplicada I
Universitat Politecnica de Catalunya,
C. Mineria 1, Esc C, 1o-3a
08038 Barcelona, Spain
E-mail: maria.isabel.garcia@upc.edu

*Abstract:-* We consider triples of matrices $(E, A, B)$, representing singular linear time invariant systems in the form, $E\dot{x}(t) = Ax(t) + Bu(t)$, with $E, A \in M_{p\times n}(\mathbb{C})$ and $B \in M_{n\times m}(\mathbb{C})$, under proportional and derivative feedback. Analyzing the tangent and normal space to the each equivalence classes we can derive information about sensitivity and stability of the triples of matrices representing singular linear systems. The Knowledge of a complete system of invariants classifying the triples permit us to give a hierarchic order relating the degree of stability of the systems.

**Brief Biography of the Speaker:**
Professor Dr. Maria Isabel Garcia-Planas joined the Department of Applied Mathematics at the "Universitat Politecnica de Catalunya" Barcelona, Spain in 1981. Her work had been centred on Linear Algebra, Systems and Control Theory. She has authored over eighty papers and serves on the referee on several journals.
She has been plenary Speaker in WSEAS Int. Conf. on Applied and Theoretical Math, Vravrona, Grecia (2000), WSEAS International Conference SIM'01, Qawra, Malta, (2001), 6th WSEAS CSCC, Creta, (2002), 4th WSEAS-ISTACS. Puerto de la Cruz, (2004), 8th WSEAS Int. Conference on Applied Mathematics, Puerto de la Cruz, (2005), 11th WSEAS Int. Conf. on Systems, Creta, (2007), Applied Computing Conference, Istanbul Turkey, (2008).

## Plenary Lecture 2

# Statistical Kernel Estimators for Data Analysis and Exploration Tasks – Theory and Applications

**Professor Piotr Kulczycki**
Systems Research Institute, Polish Academy of Sciences
ul. Newelska 6, PL-01-447 Warsaw, Poland
E-mail: kulczycki@ibspan.waw.pl
Cracow University of Technology
Head of Department of Automatic Control
ul. Warszawska 24, PL-31-155 Cracow, Poland
E-mail: kulczycki@pk.edu.pl

**Abstract:** At present, statistical kernel estimators constitute the dominant – in practice – method of nonparametric estimation. It allows the useful characterization of probability distributions without arbitrary assumptions regarding their membership to a fixed class. In this lecture their use to the basic tasks of data analysis and exploration, i.e. identification of outliers, clustering, and classification, will be considered. In every case the final result will be an algorithm ensuring that its practical implementation does not demand of the user detailed knowledge of the theoretical aspects, or laborious research and calculations. The above presented theory has been successfully applied to various practical problems of engineering and management. Two of these, the design of a fault detection and diagnosis system for automatic control purposes, and a marketing support strategy for a mobile phone operator, will be demonstrated in details. Useful procedures for the reduction of dimensionality and size of a random sample, subordinated to the specificity of kernel estimators, will also be commented.

**Brief Biography of the Speaker:**
Piotr Kulczycki graduated with a Master's degree in Control Engineering from the AGH University of Science and Technology, and a Master's degree in Applied Mathematics (with honours) from the Jagiellonian University in 1983 and 1987, respectively. He then received the scientific degrees of Ph.D. and D.Sc. (habilitation) in Control Engineering from the AGH University of Science and Technology in 1991 and 1999, respectively, followed by the title of Professor in Technical Sciences at the Systems Research Institute of the Polish Academy of Sciences in 2005. He presently holds the professor positions at the Systems Research Institute of the Polish Academy of Sciences as well as the Cracow University of Technology, where he is the Head of the Department of Control Engineering. He has held the position of visiting professor at the Aalborg University and has given guest lectures at the Technical University of Budapest, the Helsinki University of Technology, the Universite Catholique de Louvain, and the Tampere University of Technology.
Prof. Kulczycki has published 4 books and monographs and around 100 scientific works in reputable journals and international conference proceedings. These works have been quoted many times. He has also participated in 7 scientific research projects, 4 of which were conducted by international teams. The field of his scientific activity to date is the applicational aspects of information technology and data analysis and mining, mostly connected with the use of modern statistical methods and fuzzy logic in diverse issues of contemporary systems research and control engineering. He has also carried out research on artificial neural networks and the theory of differential equations. His avocational interests are centred on ancient and Napoleonic history, as well as classical music, gardening, and international tourism.

## Plenary Lecture 3

# Non-Conventional Fuzzy Connectives

**Professor Imre J. Rudas**
Rector/President
Budapest Tech
Becsi ut 96/B
H-1034, Budapest
Hungary
E-mail: rudas@bmf.hu

**Professor Janos Fodor**
Rector
Budapesti Muszaki Foiskola
1034 Budapest
Becsi ut 96/B
Hungary

**Abstract:** One of the most important and central problems of fuzzy set theory has been the proper definition of set-theoretic (or logical) operations. From the beginning of the theory, the 'min' for intersection and 'max' for union is very common and popular in the literature. This is due to the fact that they have several nice properties and are easy to work with, especially in the applications. It turned out that the justification of a class of operations - instead of any particular one - for extending crisp intersection (union and complementation) is more reasonable.
This recognition has lead researchers to the definition of t-norms, t-conorms and strong negations. Generally speaking, these connectives possess reasonable properties. But t-norms, t-conorms and strong negations can also be interpreted as many-valued extensions of the usual Boolean logical connectives conjunction, disjunction and negation, respectively. Thus it is natural that their properties have to be connected and be in accordance with that of fuzzy implications. On the other hand, if we work with binary operations and there is no need to extend them for three or more arguments then associativity is a very restrictive and unnecessary condition. In addition, the two variables in the connective may have different semantics, whence the commutativity property may also be questionable. It has also become clear that these operators do not always follow the real phenomena and do not provide optimal performance.
These facts are very often left out of consideration. Therefore, there is a natural need for finding new operators to develop more sophisticated intelligent systems.
This paper summarizes the research results of the authors that have been carried out in recent years on generalization of conventional aggregation operators. This includes, but is not limited to, the class of uninorms and nullnorms, absorbing norms, distance- and entropy-based operators, quasi-conjunctions and extended means.

**Brief Biography of the Speaker:**
Imre J. Rudas graduated from Banki Donat Polytechnic, Budapest in 1971, received the Master Degree in Mathematics from the Eotvos Lorand University, Budapest, the Ph.D. in Robotics from the Hungarian Academy of Sciences in 1987, while the Doctor of Science degree from the Hungarian Academy of Sciences in 2004. He received his first Doctor Honoris Causa degree from the Technical University of Kosice, Slovakia and the second one from “Polytechnica” University of Timisoara, Romania.
He served as the Rector of Budapest Tech from August 1, 2003 for a period of four years, and was reelected for five years in 2007. He is active as a full university professor and Head of Department of Intelligent Engineering Systems.
He is a Fellow of IEEE, Senior Administrative Committee member of IEEE Industrial Electronics Society, member of Board of Governors of IEEE SMC Society, Chairman of the Hungarian Chapters of IEEE Computational Intelligence and IEEE Systems, Man and Cybernetics Societies, and Vice-chair of IEEE Hungary Section.
He is the Vice-President of IFSA (International Fuzzy System Association), he was the President of Hungarian Fuzzy Association for ten years, President of IEEE Hungary Section.
He serves as an associate editor of some scientific journals, including IEEE Transactions on Industrial Electronics, member of editorial board of Journal of Advanced Computational Intelligence, member of various national and international scientific committees. He is the founder of the IEEE International Conference Series on Intelligent Engineering Systems (INES) and IEEE International Conference on Computational Cybernetics (ICCC), and some regional symposia. He has served as General Chairman and Program Chairman of numerous scientific international conferences.
His present areas of research activity are Computational Cybernetics, Robotics with special emphasis on Robot Control, Soft Computing, Computed-aided Process Planning, Fuzzy Control and Fuzzy Sets. He has published books, more than 400 papers in books, various scientific journals and international conference proceedings.

Janos Fodor is full professor in the Institute of Intelligent Engineering Systems, at the John von Neumann Faculty of Informatics of Budapest Tech, Budapest, Hungary. He has been Vice Rector for Science at Budapest Tech since 2005.

He received his Master Degree in Mathematics in 1981, and his Ph.D. in Mathematics in 1984 from the Eφtvφs Lorand University, Budapest. He received his C.Sc. degree from the Hungarian Academy of Sciences in 1991, and also the Dr. Habil. degree in 2000, the latter from the Eφtvφs Lorand University. He is Doctor of the Hungarian Academy of Sciences.

He has been pursuing research in mathematical foundations of fuzzy logic, computational intelligence, preference modelling, inference and decision making since 1987. He is co-author of two monographs published by Kluwer and by Springer, and of over 180 publications. He has been presented papers at more than 100 international and domestic conferences. He has been delivered numerous plenary and invited talks, and acted as General Chairman and Program Committee Chair or Member at diverse scientific international conferences.

He is Area Editor of Fuzzy Sets and Systems, member of the Editorial Advisory Board of the International Journal of Advanced Intelligence Paradigms, editor of the European Journal of Operational Research, Computing and Informatics, Surveys in Mathematics and its Applications, Acta Mechanica Slovaca, Buletin Automatica, president of the Hungarian Fuzzy Association, and coordinator of the EUROFUSE EURO Working Group on Fuzzy Sets. He has been a coordinator of several research projects. He has been Invited Professor at various universities in Belgium, Italy, France and Spain.

## Plenary Lecture 4

# Mathematical Characterization of Quantum Algorithm

**Assistant Professor Satoshi Iriyama**
Tokyo University of Science
Quantum Bio-Infomatics Center (QBIC)
Japan
E-mail: iriyama@is.noda.tus.ac.jp

**Abstract:** We have studied quantum computation for many years, and defined the generalized quantum Turing machine by using completely positive channels and density operators on the Hilbert space. This mathematical model of quantum algorithm gives us the new language classes in which the class NP is included in a polynomial time class. It has also a possibility to expand the theory of computability which has philosophical significance.
In this talk, we explain a definition of the model, the language classes, some theorems and applications.

**Brief Biography of the Speaker:**
Satoshi Iriyama is an assistant professor in Tokyo University of Science in Japan. His main research topics are the Quantum Algorithm which is the algorithm of quantum computer, the Quantum Information and Bio-Informatics. He and Professor Ohya in Tokyo University of Science proposed the mathematical model of quantum Turing machine, called a Generalized Quantum Turing Machine(GQTM for short), which is one of mathematical model of quantum computation, and defined language classes defined by GQTM. They proved that there exists a GQTM solving SAT problem, one of NP complete problems, in polynomial time. The mathematical characterization of GQTM contains the discussion of computability in the quantum computer.
He is also a researcher in Quantum Bio-Informatics Center (QBIC) in the university. The main opportunity of this center is to construct a new paradigm of Quantum Theory and Bio-Informatics. He and Professor Ohya showed the quantum algorithm for multiple alignment of amino acid sequences which is known as a difficult problem in Bio-Informatics.

## Plenary Lecture 5

# Low Dimensional Nonlinear Thermomechanical Models Describing Phase Transformations and their Applications

**Professor Roderick Melnik**
Tier I Canada Research Chair
WLU, Waterloo, ON, Canada
E-mail: rmelnik@wlu.ca

**Abstract:** In this plenary talk we focus on the development of low dimensional approximations to coupled nonlinear systems of partial differential equations (PDE) describing phase transformations. The methodology is explained on the example of nonlinear ferroelastic/thermoelastic dynamics. We start from the general three-dimensional Falk-Konopka model and with the center manifold reduction obtain a Ginzburg-Landau-Devonshire one-dimensional model. The Chebyshev collocation method is applied for the numerical analysis of this latter model, followed by the application of an extended proper orthogonal decomposition. Finally, we present several numerical results where we demonstrate performance of the developed methodology in reproducing hysteresis effects occurring during phase transformations and provide a survey of related methodologies and applied mathematical problems arising in this context.
Current project is a joint work with O. Tsviliuk and L. Wang.

**Brief Biography of the Speaker:**
Roderick Melnik is a Full Professor at the Wilfrid Laurier University in Waterloo, Canada. He is a Tier I Canada Research Chair in Mathematical Modelling. Before moving to Canada, Professor Melnik held senior professorial and research positions in the USA, Europe, and Australia. He was also a visiting fellow at the Isaac Newton Institute of the University of Cambridge , at the Institute for Mathematics and its Applications of the University of Minnesota and other research institutions in Europe, North America, and Australia. Professor Melnik's major results are in the development, analysis and applications of mathematical models based on partial differential equations and computational mathematics, focusing on coupled dynamic phenomena, systems, and processes. The areas of his research contributions include computational physics, applied numerical analysis, chemistry, and biology, non-smooth control, and stochastic differential equations. Over the past years, some of his main contributions have been to the development and applications of mathematical models in the area nano- and bionano- sciences with particular emphasis on the analysis of coupled multiscale phenomena, processes, and systems. This includes his contributions to the analysis of coupled effects in low-dimensional nanostructures, such as quantum dots, in bio-inspired and in biological systems.

# Authors Index