Editor

Jerzy Balicki

Applications of Information Systems in Engineering *and* **Bioscience**

Applications of Information Systems in Engineering *and* Bioscience

WSEAS

Gdansk, Poland, May 15-17, 2014

▼ **Proceedings of the 13th International Conference on Software Engineering, Parallel and Distributed Systems (SEPADS '14)**

▼ **Proceedings of the 5th International Conference on Bioscience and Bioinformatics (ICBB '14)**

Scientific Co-Organizer

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FACULTY OF ELECTRONICS, TELECOMMUNICATIONS AND INFORMATICS

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Preface

When one reads through the current literature on computer science, artificial intelligence, bioscience, and bioinformatics a common conclusion is: "the field of theses sciences is too young to be well defined, and its scope and limitations are still unknown". So, this book grew out of a intense and fruitful discussion related to some observations from our volume about theory and practice of modern and advanced approaches. We realized that despite the interest in data bases, software engineering, distributed systems, knowledge engineering, neural networks, fuzzy systems as evident in the major scientific journals, there were no conferences of this subject in one place to intense exchange recent models, problems and techniques between scientists.

Moreover, the question of finite differences, finite elements, finite volumes, boundary elements is experiencing rapid development, which is manifested by a powerful increase in the number of applications in this field. It should be mentioned that mathematical, computational and statistical sciences complete themselves.

During
- the 15th International Conference on Neural Networks (NN '14)
- 15th International Conference on Fuzzy Systems (FS '14)
- 13th International Conference on Artificial Intelligence, Knowledge Engineering and Data Bases (AIKED '14)
- 13th International Conference on Software Engineering, Parallel and Distributed Systems (SEPADS '14)
- 7th International Conference on Finite Differences, Finite Elements, Finite Volumes, Boundary Elements (F-and-B '14)
- 2nd International Conference on Mathematical, Computational and Statistical Sciences (MCSS '14)
- 5th International Conference on Bioscience and Bioinformatics (ICBB '14)
in Gdańsk University of Technology, Poland in 2014, an extensive collection of models, methods, applications and instances were presented due to many benefits, including information technology, engineering, medicine, and education. This is particularly contemplated in this volume.

We do not claim this text is going to answer all questions about above sciences. Indeed, we see this very much as a first attempt and hopefully not the last one. We hope it will help to mature the field and inspire researches to gain a better understanding of such a new, rich, and exciting research area.

We would like to express our appreciation to all participants our conferences who contributed to this work. We are deeply grateful to professors from twenty five countries for creating a friendly atmosphere and favorable conditions during plenary lectures. Special thanks and appreciations go to supervisors of PhD students for supporting the work of them. Many valuable suggestions and proposals, which also contributed to enrich the content of this work, we have received from researchers during fruitful discussion.

To give the final shape of the work contributed some insightful and valuable comments from reviewers. Taking into account the shortcomings identified certainly allowed the authors of individual chapters for a fuller presentation of the test subject.

We do wish to thank our families for their great support during preparation of this work.

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Jerzy Balicki
Gdańsk, May 2014

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Plenary Lecture 1

Directions of Soft Computing Techniques in Internet of Things

Professor Sung-Bae Cho
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Abstract: In the era of digital convergence new personal business assistant and entertainment equipments have appeared with many technologies such as wireless voice/data communication, digital camera, and multi-media players. As the devices get complicated, we are in need of putting together available softcomputing techniques to cope with the constraints and realize intelligent services in full scale. Since 1995 the Soft Computing Research Laboratory in Yonsei university has been exploiting the sophisticated technologies such as neural networks, evolutionary computation, fuzzy systems, and Bayesian networks, and developing the systems to solve complex real-world problems effectively by integrating them with the conventional AI technologies. In this talk, I will introduce the Soft Computing Research Laboratory and some of the projects that are pursuing advances in intelligent systems. In particular, I will present a series of prototypes that we have developed for intelligent services on smartphones.

Brief Biography of the Speaker: Sung-Bae Cho (S'88-M'93-SM'06) received the Ph.D. degree in computer science from KAIST (Korea Advanced Institute of Science and Technology), Taejeon, Korea, in 1993. He was an Invited Researcher of Human Information Processing Research Laboratories at Advanced Telecommunications Research (ATR) Institute, Kyoto, Japan from 1993 to 1995, and a Visiting Scholar at University of New South Wales, Canberra, Australia in 1998. He was also a Visiting Professor at University of British Columbia, Vancouver, Canada from 2005 to 2006, and at King Mongkut's University of Technology Thonburi, Bangkok, Thailand in 2013. Since 1995, he has been a Professor in the Department of Computer Science, Yonsei University, Seoul, Korea.

His research interests include hybrid intelligent systems, soft computing, evolutionary computation, neural networks, pattern recognition, intelligent man-machine interfaces, and games. He has published over 230 journal papers, and over 680 conference papers.

Dr. Cho has been serving as an associate editor for several journals including IEEE Transactions on CI and AI on Games (2009-present) and IEEE Transactions on Fuzzy Systems (2013-present). He was also the chair of Games Technical Committee, IEEE CIS (2009-2010), and Student Games-based Competition Subcommittee, IEEE CIS (2011-2012). He is a member of Board of Government (BoG) of Asia Pacific Neural Networks Assembly (APNNA) (2011-present), and a member of three technical committees in IEEE CIS such as Emergent Technologies, Computational Finance and Economics, and Games.

Dr. Cho has been awarded several best paper prizes from IEEE Korea Section (1990), Korea Information Science Society (1993, 2005), International Conference on Soft Computing (1996, 1998), World Automation Congress (1998), International Conference on Information Networking (2001), and International Conference on Hybrid AI Systems (2011). He was also the recipient of the Richard E. Merwin prize from IEEE Computer Society in 1993.

Plenary Lecture 2

Big Data Analytics - Searching the Empty Space

Professor Wolfgang Benn
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Professur Datenverwaltungssysteme
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Abstract: Big Data Analytics means to find the needle in a (big-data-)haystack. To find an answer for analytic questions often results in queries to databases, which have lots of predicates and which need tenth or hundredth of values to be correlated to select the correct data records. These correlations create a very large search space because each value is located in its own dimension. Thus, one problem of these queries is that they often search large parts of the database but do not find records for the result set, because the more dimensions we have, the more we search the empty space. Another problem is that such kind of queries very often need to tackle more than one database. The talk will be about a method that helps to avoid the empty space search by use of Artificial Intelligence and which can simply be used to access more than one database at a time.

Brief Biography of the Speaker: http://www.tu-chemnitz.de/informatik/DVS/chef.php

Plenary Lecture 3

Quantum-Inspired Multi-Objective Evolutionary Algorithms for Decision Making: Analyzing the State-Of-The-Art

Associate Professor Jerzy Balicki
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Abstract: Over the past decade, multi-objective evolutionary algorithms have been the most commonly used meta-heuristic approaches for decision making support. However, they consume a lot of time to calculate the representative set of efficient solutions. To avoid this disadvantage, some improvements have been introduced.

Especially, some quantum-based algorithms seem to be very promising and prospective [2, 4]. However, there are not widely available quantum computers and the quantum-inspired algorithms are simulated on classical computers to achieve the quantum effect. In such a way quantum-inspired algorithms can be used for a computer decision aid, too [3, 6].

Kim J., Kim J.-H., and Han have been proposed probably the first quantum-inspired multiobjective evolutionary algorithm called QMEA for Multiobjective 0/1 Knapsack Problems in 2006 [5]. To improve the quality of the nondominated set as well as the diversity of population, QMEA develops some principles of quantum computing such as uncertainty, superposition, and interference. Experimental results show that QMEA finds solutions close to the Pareto-optimal front while maintaining a better spread of nondominated set.

QMEA is based on NSGA-II that is a strong elitist method with mechanisms to maintain diversity efficiently using nondominated sorting and crowding distance assignment. It is even more powerful if the elitism is further strengthened and the solutions are spread out by quantum mechanism.

Moreover, Talbi, Batouche, and Draao have been considered a Quantum-Inspired Evolutionary Algorithm QEA for multiobjective image segmentation [7].

Decision making by the AQMEA (Adaptive Quantum-based Multi-criterion Evolutionary Algorithm) has been considered for distributed computer systems, too [1]. Evolutionary computing with Q-bit chromosomes has been proofed to characterize by the enhanced population diversity than other representations, since individuals represent a linear superposition of states probabilistically.

In this paper, multi-criterion, evolutionary and quantum decision making supported by the Adaptive Quantum-based Multi-criterion Evolutionary Algorithm (AQMEA) has been considered. AQMEA has been developed to the task assignment problem and to underwater vehicle planning. Moreover, the other algorithms like QMEA and QEA have been discussed.

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Brief Biography of the Speaker: Jerzy M. Balicki is an associative professor at the Faculty of Electronics, Telecommunications and Informatics, Gdansk University of Technology 11/12 G. Narutowicza Street, 80-233 Gdańsk, Poland (e-mail: Balicki@eti.pg.gda.pl, http://www.eti.pg.gda.pl/katedry/kask/pracownicy/Jerzy.Balicki/). He received the M.Sc. and Ph.D. degrees in Computer Science from University of Military Technology, Warsaw, Poland in 1982 and 1987, respectively. Then, he achieved habilitation D.Sc. from Technical University of Poznan in 2001.He

was as a university professor at Naval University of Gdynia from 2002 to 2010, and then at Gdansk University of Technology, Poland. He is an author of three books and more than 170 scientific papers related to artificial intelligence, distributed computer systems, quantum computations and decision support systems.

Plenary Lecture 4

Modern Parallel Computing Using Heterogeneous Systems with Multicore CPUs and Accelerators
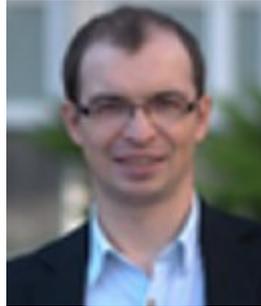
Assistant Professor Paweł Czarnul
Dept. of Computer Architecture
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Abstract: The presentation focuses on the state-of-the-art in modern parallel and distributed computing including key challenges and solutions. Parallel processing using multicore CPUs, GPU and other accelerators such as Intel Xeon Phi will be discussed. Currently, there is a variety of programming APIs for parallel computing at various levels. This includes solutions for:

1. GPUs [1, 2] such as NVIDIA CUDA, OpenCL, OpenACC [3] as well as accelerators such as Intel Xeon Phi with MPI [4], OpenMP [5] and OpenCL,
2. multicore CPUs such as OpenMP or OpenCL,
3. mixed GPU and CPU systems with OpenCL or hybrid approaches e.g. MPI and CUDA etc.,
4. cluster level including e.g. MPI,
5. grid systems with grid middlewares such as Globus Toolkit, BeesyCluster [6] etc.

This brings us to the need for knowledge of both parallelization techniques as well as particular APIs in order to make the most of today's high performance computing systems. In view of this, a new KernelHive system is presented that allows easy parallelization of computations in multi-level heterogeneous environments including CPUs and GPUs. On one hand, it allows easy definition of applications using a graphical editor. A complex scenario might be expressed as an acyclic directed graph (workflow) in which vertices are assigned various types of code. These types include computational kernels in OpenCL, partitioning, merging and other pieces. Kernels are stored in a library from where can be reused for subsequent projects and applications. The user needs to point input data sets in possibly remote locations by giving proper URLs to data. If needed, new custom built kernels may be easily developed using an editor built into the GUI.

The GUI of the system communicates with the engine that is reponsible for management of several possibly distributed clusters from where dedicated managers communicate with the engine. Following a hierarchical structure, within clusters several node managers report to the cluster manager and within each node, management of compute devices such as CPUs and GPUs is performed. At this low level, several custom processing frameworks can be provided such as master-slave or SPMD.

The engine of the system has been designed in a modular way and allows new plugins for so-called optimizers. Optimizers provide solutions such as specific algorithms for data partitioning and scheduling of computations across underlying collection of compute devices taking into account granularity and communication. This is especially important because in modern HPC systems, performance is not the only optimization goal.

Goals such as performance under power consumption constraints, power efficiency of parallel systems [7] are discussed. Modern CPUs and accelerators provide ways for management of power consumption including imposing constraints. Such mechanisms can be used for optimization within systems such as KernelHive [8]. This might be useful in real life situations in which, for example, temporary power consumption limits may be imposed on computing servers.

Finally, visualization of system state, application progress as well as runtime representation of computations running on both CPUs and GPUs within KernelHive will be presented. KernelHive separates processing within OpenCL kernels from visualization code implemented in Java. In the former, preview objects can be populated with data and then flexibly visualized in the Java layer.

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Brief Biography of the Speaker: Paweł Czarnul is an Assistant Professor at Dept. of Computer Architecture, Faculty of Electronics, Telecommunications and Informatics, Gdansk University of Technology, Poland. He obtained his MSc and PhD degrees from Gdansk University of Technology in 1999 and 2003 respectively. He spent 2001-2002 at Radiation Lab in Electrical Engineering and Computer Science Dept. of University of Michigan, USA working on code parallelization using dynamic repartitioning techniques. He is the author of over 70 publications in the area of parallel and distributed computing, including journals such as International Journal of High Performance Computing Applications, Journal of Supercomputing, Metrology and Measurement Systems, Multiagent and Grid Systems, Scalable Computing etc. and conferences such as EuroPVMMPI, PPAM, ICCS, IMCSIT and many others. He actively participated in 12 international and national grants, being the director of 3 projects. Currently the director of national project "Modeling efficiency, reliability and power consumption of multilevel parallel HPC systems using CPUs and GPUs". A reviewer for international journals such as IEEE Transactions on Parallel and Distributed Systems, Journal of Parallel and Distributed Systems, Journal of Supercomputing, Computing and Informatics etc., for conferences including PPAM, GRID, ICCS, Workshops on Software Services, Workshop on Cloud-enabled Business Process Management, BalticDB&IS, IDAACS etc. An expert in an international board on Software Services within the SPRERS project.

His research interests include parallel and distributed computing, high performance computing including GPGPUs, Internet and mobile technologies. The leader of the BeesyCluster project (https://beesycluster.eti.pg.gda.pl:10030/ek/AS_LogIn) that provides middleware for a service oriented integration of computational and general purpose hardware resources with advanced workflow management system and support for clouds. A co-designer of the COMCUTE (http://comcute.eti.pg.gda.pl/) project for volunteer computing within user browser with control of redundancy and reliability. A co-designer of KernelHive (http://kask.eti.pg.gda.pl/en/projekty/kernelhive/) for automatic parallelization of computations among clusters with GPUs and multicore CPUs. The author of DAMPVM/DAC (http://pczarnul.eti.pg.gda.pl/DAMPVM.html) for automatic parallelization of divide-and-conquer applications.

Plenary Lecture 5

Science and Technology in Biomedical Engineering: LaBACS Case Example

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Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture
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Abstract: The lecture presents the scientific efforts of the group of engineers and scientists from the Laboratory of Biomechanics and Automatic Control Systems – LaBACS, University of Split, Croatia. The field of our expertise is biomedical engineering, and we are dedicated to find the solutions for various current biomedical engineering problems. The primary goals of our research interests are to develop new, state-of-the-art, cost-effective biomedical and biomechanical measurement systems and to apply them on the human subjects to obtain scientifically significant results. Lecture presents a review of some of our newly developed measurement systems and digital signal processing techniques and algorithms for processing and analysis of measured biomechanical and biomedical signals.

Brief Biography of the Speaker: Tamara Grujic graduated with a B.S. degree in electrical engineering in 1999, and then with a M.S. degree in electrical engineering from University of Split, Croatia in 2003. She graduated in 2006 with a Ph.D. degree in biomedical engineering from University of Ljubljana, Slovenia. Since 2000 she has been a faculty member of Faculty of Electrical Engineering, Mechanical Engineering, and Naval Architecture at the University of Split, Croatia, serving as a research assistant from 2000 to 2007, assistant professor from 2007 to 2011, an associate professor since 2011. Her research interests include signals and systems in biomedical engineering (particularly electromyography), biomechanics (particularly biomechanics of human gait and upper limb), design and development of optical motion tracking systems and algorithms in machine learning. She is author of more than 30 papers published in international journals and conference proceedings.

Plenary Lecture 6

New Concepts in Assistive Living Technologies

Professor Mirjana Bonković
Laboratory for Modelling and Intelligent Systems - LaRIS
Faculty of Electrical Engineering, Mechanical Engineering, and Naval Architecture
University of Split
Croatia
E-mail: mirjana.bonkovic@fesb.hr

Abstract: Modern technologies have become a part of everyday human living helping in performing human routine activities or health monitoring. They are a source of human habits information, useful for behavior correction or the source of interesting information for marketing corporations.

Typical solutions assume various types of assistive technologies which make living easier especially to elderly population or to those who are unable to take a care about themselves. Those systems can be used to monitor the vital signs continuously over a 24 hour period and are in some cases crucial for understanding the progression of chronic symptoms of illness, such as asthma disease.

On the other side, measuring the people habits has always been a subject of marketing corporation interest. Hence, there are lot of products recently, known as peoplemeters or audience meters, which measure people attention under various circumstances such as watching different TV channels, or measurement of people interest in some commercial offers.

In this lecture, a new concepts in assistive living technologies will be presented with special focus on the systems developed in the Laboratory for Modelling and Intelligent System at the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split, Croatia.

Brief Biography of the Speaker: Mirjana Bonkovic graduated with a B.S. degree in electrical engineering in 1990, and then with a M.S. degree in electrical engineering in 1994 and graduated in 2000 with a Ph.D. degree in automatic control from University of Split, Croatia. Since 1991 she has been a faculty member of Faculty of Electrical Engineering, Mechanical Engineering, and Naval Architecture at the University of Split, Croatia, serving as a research assistant from 1991 to 2002, assistant professor from 2002 to 2005, an associate professor from 2005 to 2010, and full professor since 2010. Her research interests include vision based robotics, signals and systems in biomedical engineering (particularly application of machine learning algorithms), image processing with applications on human tracking and identification and optimization algorithms in control. She is author of more than 30 papers published in international journals and conference proceedings.

Plenary Lecture 7

Nano- and Bio-Structured Materials and Their Photorefractive Features

Dr. Sci., PhD Natalia V. Kamanina
Vavilov State Optical Institute
&
Prof. at Saint-Petersburg Electrotechical University (LETI)
Russia
E-mail: nvkamanina@mail.ru

Abstract: The spectral and photorefractive parameters of some organic materials, including the liquid crystal (LC) ones, doped with nano- and bio-particles have been studied using optical limiting and holographic recording techniques in the visible . Some evidences of the influence of the nanoobjects doping on the self-assembling and wetting phenomena have been established. The area of application of the materials to be used in the optoelectronics and biomedicine has been discussed.

Brief Biography of the Speaker: Dr. Sci. PhD. Natalia Vladimirovna Kamanina was born in Kaliningrad, Russian Federation, 1957. She graduated with an Honor Diploma from Leningrad Polytechnical Institute (1981), St. Petersburg, Russia, and received a PhD (Physics & Mathematics) at Vavilov State Optical Institute, St.-Petersburg, Russia (1995), as well as a Dr. Sci. (Physics & Mathematics) at the same institution (2001). She is currently a Head of the Lab for "Photophysics of media with nanoobjects" at Vavilov State Optical Institute St.-Petersburg, Russia and has been involved in collaboration research with many researchers and scientists all over the world since 1995, publishing about 190 technical papers in the area of Laser-Matter Interaction and Nanotechnology. Parallel to her scientific activity, she has also been lecturing from 2001 up to now, as a Professor of Quantum Electronics and Opto-Electron Device at St. Petersburg Electrotechnical University ("LETI"), and a Professor of the Optical Physics and Modern Natural Science (2002-2013) at St. Petersburg Technical University "IFMO".

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