



# UNIVERSITY OF SILESIA

## INSTITUTE OF COMPUTER SCIENCE

### ANNUAL REPORT 2012



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## 1. Introduction

The Institute of Computer Science was founded as the Institute of Scientific and Technical Information in 1974. Since then it has offered the master's program in the discipline of scientific and technical information. In 1993 the three-year program leading to the Licentiate's Title in Computer Science replaced that program. In 1994 the institute changed its name into the Institute of Applied Computer Science, and in 1997 into the Institute of Computer Science.

Education in computer science consist of two stages: three-and-a-half-year engineer's studies and two-year master's studies. Education in biomedical engineering is organized into one stage: three-year engineer's studies. In the academic year 2012/2013 there were enrolled 188 engineer's and 76 master's students in computer science, and 88 students in biomedical engineering. The institute is a part of the Faculty of Computer Science and Material Science ([www.wiinom.us.edu.pl](http://www.wiinom.us.edu.pl)) of the University of Silesia ([www.us.edu.pl](http://www.us.edu.pl)). Since 2002 the Faculty of Computer Science and Material Science can award PhD degrees in computer science.

Professor Zygmunt Wróbel has been acting as headmaster of the Institute since 2012.

The institute consists of:

- Division of Information Systems (<http://zsi.tech.us.edu.pl/>)  
head: Professor Alicja Wakulicz-Deja
- Division of Computer Systems (<http://zsk.tech.us.edu.pl/>)  
head: Professor Piotr Porwik
- Division of Algorithmics and Computational Intelligence (<http://zaiio.ii.us.edu.pl/>)  
head: Professor Urszula Boryczka
- Division of Modeling and Computer Graphics (<http://zmigk.ii.us.edu.pl/>)  
head: Professor Wiesław Kotarski
- Division of Biomedical Computer Systems (<http://zksb.ii.us.edu.pl/>)  
head: Professor Zygmunt Wróbel

## **2. Research**

### **2.1. Areas of specialization**

The Institute of Computer Science conducts research in the following areas:

#### **Expert systems**

The primary aim of studies is the development of the theoretical basis for designing and implementing expert systems. The validation and verification methods of knowledge databases are investigated. The design principles of support decision systems with knowledge databases verification are developed. Besides theoretical studies concerning the methods of knowledge base creation, the works on practical implementation of the support decision systems comprising knowledge verification module are also undertaken. The implementation of such systems requires an analysis of methods of knowledge representation and concluding.

The other direction of research is an application of the rough set theory for constructing support decision systems. With this regard the studies focus on the problem of multi-step diagnosing based on uncertain and incomplete information. Making up a decision requires some rough classification to be done where the steps of the classification are connected with a real diagnosing process carried out by experts. An example of such a complex diagnosing system is the support decision system for children neurology, which was realised in co-operation with the Children's Neurology Clinic of the Silesian Medical Academy. On this system the proposed solutions based on the rough sets theory are verified.

Recently, the very important directions of our research are composited knowledge bases (huge number of rules in a knowledge base with numerous premises in each rule, a large set of attributes, many of which are dependent) and inference processes on such bases. The studies also concern problems of complex medical data processing.

#### **Biometric techniques**

Various experiments with biometric systems that work as recognition units have been carried out recently. These investigations follow from contemporary needs of a security. Researchers are conducted for three types of the biometric systems: fingerprints, signatures and voice recognition, where different image processing techniques are checked. Additionally, various similarity measures are also proposed and their effectiveness is tested in practical experiments.

The main goal of investigations is to find efficient methods which can help in behavioural description of the persons. There are some dedicated solutions proposed where statistical methods and individually selected similarity measures are applied in biometric recognition systems. These measures are selected on the basis of behavioural characteristics of the person.

In this researches both the static and dynamic features of the analysed objects are extracted and next used in the recognition process. Many experiments have been realized basing on own databases where signatures and finger imprints samples are stored. These databases have been created during recent years.

### **Spectral analysis of the Boolean functions**

In these investigations some properties of the Boolean functions are recognised. In this approach the basis of the orthogonal Walsh and Haar functions are used and spectrum of the Boolean function in these bases is analysed. The distribution and values of the spectral coefficients can indicate type of the function (linear, affine, bent, etc.). Various decomposition methods of Boolean function have been applied and are still tested. The researches are conducted for fully and weakly defined functions. Investigations are carried out for large functions where classical calculation of the spectrum is impossible. For this reason there are proposed methods where on the basis of the reduced spectrum, type of Boolean functions can also be recognised.

### **Multiresolution methods in Computer Graphics and Image Processing**

The aim of investigations is to find efficient and fast algorithms that can be applied in computer graphics and image processing. Researchers are concentrated on two main scientific tasks.

The first one relates to fractal modeling and coding of 2D and 3D graphics together with their multiresolution representation. Fractal modeling is based on relation between IFS (Iterated Function Systems) coefficients and subdivision schemes together with new ideas (fractal homeomorphisms, stealing colours, V-fractals, superfractals) discovered recently by Barnsley. Fractal algorithms are interesting for practice because they need a small amount of information to generate resolution independent graphics and additionally in the progressive way. Progressiveness and resolution independency are very desirable features while transmitting graphical information through the net.

The second task relates to effective sparse multiresolution geometrical representation of images and their processing. The use of geometrical wavelets in image processing, especially adaptive methods, could lead to efficient algorithms among others in denoising, segmentation, edge detection or compression. Due to the fact that geometrical methods reflect Human Visual System in some sense such methods may be used in very advanced techniques of object detection or recognition. Another application may be found in content based compression. Additionally, building of fast algorithms could lead to real time applications in the all mentioned areas.

### **Analysis and processing of biomedical images**

The project is devoted to the algorithms of analysis, processing and recognition of images applied in the identification of pathological states. By images we understand „classic“ biomedical images. This group comprises X-ray, ultrasonic, thermovision images, as well as the microscopic images of tissues. In addition, two-dimensional images, so called biomedical signals, are analysed and processed. Among them are EKG and EEG signals, cardiograph records of heart action, sounds of pathological speech etc.

### **Hospital computer systems**

The aim of hospital computer systems is to improve acquisition, transmission and processing of data generated by measuring sensors and medical apparatuses. This in turn improves the quality of medical care, decreases its cost and has a positive impact on the

administrative and financial activities of hospitals. In the project the distributed system of dynamic microbiological investigations in the networked computer system of a hospital is elaborated.

### **Computer techniques in biotechnology**

The work of biological objects can be considered as a problem of controlling a multi-level object described by a set of parameters related with each other. The research group working on the application of computer techniques in biotechnology constructs new measurement converters and medical apparatuses in order to perform complex biomedical and biotechnological procedures. The recent project was devoted to programmable control of biotechnological systems.

### **Computerization of administrative processes**

The subject of research is expert systems for the local administration needs. The research concentrates on general conditions of the computerization of administrative processes. In particular they comprise the legal foundations of computerization of management processes, such as the structure and tasks of the administrative bodies and the legal rules of using computer programs and automated databases. One of the research subjects concerns the systems of spatial information systems and personal data protection.

### **Computational swarm intelligence**

Swarm intelligence is an artificial intelligence technique involving the study of collective behavior in decentralized systems. Such systems are made up by a population of simple agents interacting locally with one other and with their environment. Although there is typically no centralized control dictating the behavior of the agents, local interactions among the agents often cause a global pattern to emerge. Examples of systems like this can be found in nature, including ant colonies, bird flocking, animal herding, honey bees, bacteria, and many more. Swarm Intelligence techniques have mainly been applied to continuous nonlinear numerical optimization and in many real world optimization problems, especially in discrete optimization (TSP, JSP, TTP, MKP etc). Its convergence rate also make them a preferred tool in dynamic environments: transportation networks and routing optimization (multi-objective optimization), constrained optimization, niching, game theory, data mining and data clustering.

### **Heuristic and evolutionary algorithms**

The heuristic and evolutionary algorithms for solving combinatorial optimization problems are studied. These problems arise in many areas of applications. The algorithms use the concepts derived from artificial intelligence, biological, mathematical, and natural and physical sciences. The ant systems in the context of the travelling salesman, bus-scheduling and vehicle routing problems are investigated. Special attention is paid to the generative policies improving the performance of ant systems. The leader and elite strategies modeled upon the behaviour of real ants are examples of such policies. The vehicle routing problem with time windows which belong to the NP-hard problems is also solved by making use a variety of algorithms, including parallel simulated annealing. All these algorithms employ a local neighbourhood search and are probabilistic in nature. The way a neighbourhood structure is defined and randomness is

introduced influence significantly the performance of algorithms. Yet another direction of research we carry out is genetic programming. In this regard the influence of grammars describing the generated programs on the efficiency of genetic programming is studied.

## **2.2. Research grants**

### **Analysis of eye tomographic images**

MSHE grant No.: N N518 427036, 2009-2010, 70.400 PLN

Principal investigator: Robert Koprowski, PhD

Co-principal investigator: Professor Zygmunt Wróbel

An optical tomography is a modern non-invasive technique for a tissue section imaging, in this case of eye's retina, using the light scattered on individual layers of the examined tissue. The spectral tomography, as compared with the hitherto solutions (e.g. time tomography), features much high resolution. The elimination of a moving mirror, necessary to scan deep into the object examined, allows also shortening the examination time (object scanning) approx. a hundred times. A short time of scan performance as well as its sequentiality and maintaining a constant shift allows obtaining 3D images.

The project is aimed at developing a software, which should enable a fully automated analysis of individual fractions visible on 2D images and thereby their 3D reconstruction. So in this case the key issue becomes the algorithm using both known and also new (developed under this project) techniques of images processing, enabling fully automated separation of characteristic areas on eye tomographic images.

A measurable effect of the project will comprise not only developing the aforementioned algorithm, but also preparing a monograph "Automated methods of eye tomographic images analysis".

### **Computer analysis of the mechanical properties of bone microstructure using model of spatial distribution of density**

MNiSW grant No.: N N518 425036, 2009-2011, 398.100 PLN

Principal investigator: Marcin Binkowski, PhD

Co-principal investigator: Professor Zygmunt Wróbel, Professor Antoni John (Silesian University of Technology)

The main aim of the project is performing methodology which allows identification of biomechanical properties of the bone microstructure. It will be performed based on model of spatial distribution of bone density which is defined based on quantitative micro computed tomography.

The definition of high resolution numerical model which allows strength analysis is the powerful meaning of the project. The results of the project will allow perdition of mechanical properties of the modelled bone.

As a final effect of the project study of relationship between changes of the bone microstructure density (or nanostructure) and related decreasing of mechanical strength will allow for significant extending knowledge build as so far based on quantitative analysis of the microstructure geometry measured by histomorphometrical parameters. In such a high

resolution measurement the changes in bone mineral density the quantitative identification of bone density distribution particularly for single trabecular and/or slim layer of the cortical bone.

Thanks to applying QmicroCT the analysis of the three dimensional parameters of microstructure/nanostructure will be possible. It will increase possibilities of delivering a new data to the medical diagnosis process and probably earlier diagnosis and successful treatment of osteoporosis and other diseases of the bone tissue. In addition there will be possible advantages changes in animal laboratory studies (rats, mice) related to both reduced number of individuals evolved in studies and providing more precise information related to bone density.

As a final conclusion, it is worth to underline the most important project advantage: the results will allow the beginning of discussion about bone tissue densitometry performed on the fundamental structural element, which not damage and three dimensional quantitative assessments is as so far unobtainable.

### **Applying the quantitative X-ray microcomputed tomography in establishing a standard for bone mineral measurement**

Support grant for research in Poland after Post-doctoral fellowship.

Foundation for Polish Science 2009-2011, 40.000 PLN

Principal investigator: Marcin Binkowski, PhD

The main aim of the project is applying the Quantitative X-ray microcomputed tomography (QXMT) in estimation of bone mineral density in the animal bone samples. This method will be useful in establishing the new standard for the XMT measurement. Until today laboratories are doing research based on own protocols, as there is no common and accepted standard, which could be applied in each facility.

The research will be carry on based on rat bone samples. Tibias and femurs will be tested by several XMT scanners to deliver wide range of the results.

The method QXMT was laboured during previous project performed in 2007-2008 during postdoctoral research at the University College London. It enables quantitative measurement of the bone density therefore it can be successfully used as a tool to deliver correct measurement factors. Those factors will be then processed to estimate appropriate standard of the bone density measurement.

Establishing and applying the XMT standard will accelerate bone research performed across-laboratories and across the scanners.

### **Equipment for quantitative high-resolution computed tomography facility**

No contract: 393/FNITP/160/2010, 2010-2011, 1.675.000 PLN

Principal investigator: Marcin Binkowski, PhD

Co-principal investigator: Professor Zygmunt Wróbel

X-ray microcomputed tomography is a method which can be used to non-invasive scanning of the objects, which are subject of scientific research performed in Department of Biomedical Computer System (DBCS) in the Institute of Computer Science (CS). Based on tomography procedure objects can be imaged and measured in terms of three dimensional geometry, and distribution of relative density.



From 10 years this technique had been used in DBCS. Based on gained experience and funds if grant will be granted for our proposal a new laboratory will be constructed and equipped with high level X-ray volumetric scanner.

The laboratory will be the first laboratory in CS building, what provides new opportunity for DBCS giving an experimental support for existing and new projects.

Particularly, study of bone microstructure, measurement of the bone mineral density, and imaging other medical specimens will be continued based on own laboratory.

In addition X-ray facility will provide exceptional opportunity for wide interdisciplinary cooperation based on project related to tissue engineering, geology, palaeontology, electronics, material science, nutrition, chemical and many other fields.

Proposed facility will open a new opportunity for cooperation with other Department at the CS, faculties at the University of Silesia, as well as other University from Poland and abroad.

### **Analysis and quality enhancing of digital fingerprint images**

MSHE grant No.: N N519 574038, 2010-2011, 39.820 PLN

Principal investigator: Professor Piotr Porwik

Co-principal investigator: Łukasz Więclaw, PhD

In the supervisor's research grant (no N N519 574038), the investigations are carried out collectively with the Central Forensic Laboratory of the Polish Police Fingerprint Department, Warsaw. In these research studies, attempts are undertaken to acquire of biometric data based on separated data of fingerprint records. The new image processing technique is designed and tested by a doctoral student of the Computer Systems Department, University of Silesia, Katowice. Investigation results will be published and the prepared software will be used in different Polish police departments, especially by the Fingerprint Department. Investigation results will be elements of the Ł. Więclaw's doctoral thesis, working under the prof. P. Porwik's supervision.

### **Equipping the Laboratory of Quantitative Analysis and Modelling Biomaterial Surfaces with a measuring confocal laser scanning microscope**

Contract No.: 599/FNITP/160/2010, 2010-2011, 695.000 PLN

Principal investigator: Sebastian Stach, PhD

Co-principal investigator: Professor Zygmunt Wróbel

The aim of this project is to develop a comprehensive system of analysing and modelling the surface and structure of engineering materials, with a particular emphasis on biomaterials.

With this view in mind, systems have been developed and optimised, which constitute an optical metrology tool and are called measuring confocal Laser Scanning Microscopes (mCLSM). They have proved to be very effective in image processing, even in the case of the most complex surface topologies.

Such systems use a laser with a wavelength of 405 nm, with extremely enhanced optics to provide very high resolution. Owing to the application of UV laser light in a combination with a confocal scanner, the optical capacity threshold as known for conventional equipment, has been exceeded.

The resolution has been increased through using a confocal scanning technique. In this method, the surface of a sample is scanned point by point. Control of movement in axis Z is extremely precise owing to the linear system with a 1 nm increment.

The measuring apparatus added to the profile of the laboratory being created will be the key support for the works conducted not only at the University of Silesia, but also for its partner centres, such as The Silesian University of Technology or the Medical University of Silesia.

### **Exploration of rule knowledge bases**

MSHE grant No.: 2011/03/D/ST6/03027, 2012-2015, 451 400,00 PLN

Principal investigator: PhD Agnieszka Nowak – Brzezińska

The aim of the research is to develop theoretical foundations and methods of exploring patterns and relationships which can be found in large rule-based knowledge systems and to introduce new methods of inference. It is a recently arisen issue of high importance, both in terms of theoretical and practical aspects. It requires the research of a fundamental nature, but also a methodological study and vast implementational considerations. In the scope of essential research the results will include: (1) developing the concept of a knowledge base meta-model and a study of its formal description and all of the properties, (2) development of methods for the extraction of the proposed model from rule bases of big volume, including the scalability and effectiveness of the proposed approach and (3) development of novel inference methods for the created model.

A modular, hierarchically organised rule based system using the cluster analysis method and decision units is planned to be built. These methods have been successfully used in the optimisation of the inference task due to the analysis of the internal properties discovered in the rule sets. Further part in this section introduces an extension of the clustered rules and the decision units oriented for extraction of the additional knowledge from rule-based knowledge bases.

The practical result will be achieved by the development of a computer software utilising the created model and methods of its analysis, with an interactive visualisation and knowledge base meta-model analysis subsystem including the presentation and interpretation layer of the discovered relationships. The software will be a tool which implements domain decision-making system, acting as both a tool for the knowledge engineer and a runtime environment for the target domain system.

### 2.3. Recent publications

The lists of publications by the members of the institute given below contain only the publications written in English.

#### 2010

Binkowski M., John A., Nowak R., Bożek M., Bielecki M., Differences in trabecular bone mechanical strength measured by the X-ray microcomputed tomography and compressive test., *Journal of Medical Informatics & Technologies*, (2010), vol. 15, 163-168.

Boryczka U., Kozak J., Ant Colony Decision Trees – A New Method for Constructing Decision Trees Based on Ant Colony Optimization. Jeng-Shyang Pan, Shyi-Ming Chen, Ngoc Nguyen editors, *Computational Collective Intelligence. Technologies and Applications*, wolumen 6421 serii *Lecture Notes in Computer Science*, Springer Berlin / Heidelberg, (2010), 373–382.

Boryczka U., Juszczuk P., Using Differential Evolution to find optimal mixed strategies in two players matrix games. 16th International Conference on Soft Computing - MENDEL, (2010), 535-541.

Boryczka U., Juszczuk P., Comparative Study of the Differential Evolution and Approximation Algorithms for Computing Optimal Mixed Strategies in Zero-Sum Games. the 2nd International Conference on Computational Collective Intelligence - Technology and Applications, Springer-Verlag serii *Lecture Notes in Computer Science*, vol. 6421, (2010), 363-372.

Boryczka M., Bura W., Ant colony system in ambulance navigation, *Journal of Medical Informatics & Technologies*, vol. 15, (2010), 115-124.

Chikalov I., Moshkov M., Zielosko B., Upper bounds on minimum cardinality of reducts and depth of decision trees for decision tables with many-valued decisions. *Concurrency, Specification and Programming*. Helenenau (near Berlin), Sept. 27 – 29, (2010), 97-103, <http://www2.informatik.hu-berlin.de/ki/CSP2010/>

Chikalov I., Moshkov M., Zielosko B., Upper bounds on minimum cardinality of exact and approximate reducts. In: Szczuka, M. et al.(eds.) *RSCTC 2010, LNCS (LNAI) 6086*, Springer, Heidelberg, (2010), 412-417.

Chodacki M., On Enhancing Diagnostic Effectiveness of Autonomous Test Structures for Digital Circuits of Medical Devices, *Journal of Medical Informatics & Technologies*, vol. 16, (2010), 51-57.

Chromiński K., Tkacz M., Comparison of outlier detection methods in biomedical data, *Journal of Medical Informatics & Technologies*, vol.16, (2010), 89-94.

Czech, Z.J., A parallel simulated annealing algorithm as a tool for fitness landscape exploration, W: Ros, A., (ed.), Parallel and Distributed Computing, In-Tech, Vukovar, Croatia, (2010), chapter 13, 247-271.

Czech, Z.J., Mikanik, W., Skinderowicz, R., Implementing a parallel simulated annealing algorithm, 8th International Conference on Parallel Processing and Applied Mathematics, LNCS, vol. 6067, (2010), 146-155.

Delimata P., Marszał-Paszek B., Moshkov M., Paszek P., Skowron A., Suraj Z., Comparison of Some Classification Algorithms Based on Deterministic and Nondeterministic Decision Rules. W: J.F. Peters et al. (ed.): Transactions on Rough Sets XII, LNCS, vol. 6190, Springer-Verlag Berlin Heidelberg (2010), 90-105.

Domańska, D., Wojtylak, M., Air Pollution Forecasting Model Control. Journal of Medical Informatics & Technologies, vol. 14, (2010), 9-22.

Domańska, D., Wojtylak, M., Change the Sequence Into Fuzzy Number. Lecture Notes in Computer Science, vol. 6441, (2010), 55-62.

Doroz R., Kostorz I., The method for determining the characteristic points of signatures based on IPAN99 algorithm, Journal of Medical Informatics & Technologies, vol.15, (2010), 41-46.

Doroz R., Wrobel K., Determining the similarity of signatures on the basis of characteristic points analysis. International Journal of Biometrics (IJBM), Interscience Publisher, vol. 2, no.3, (2010), 282-294.

Elpiniki I. Papageorgiou, Froelich W., Forecasting the state of pulmonary infection by the application of fuzzy cognitive maps, in Proceedings of the 10th IEEE International Conference on Information Technology and Applications in Biomedicine, Corfu, Greece, November 2-5, IEEE, (2010).

Froelich W., Wakulicz-Deja A., Medical diagnosis support by the application of associational fuzzy cognitive maps, Control and Cybernetics, vol. 39, no. 2, (2010), 439-456.

Gajos M., Aspects of innovation in geoinformation, In: Space, Heritage and Future, Hrvatski Informaticki Zbor – GIS Forum, University of Silesia, Zagreb, (2010), 11-15.

Gajos M., Geomatics in forestry. Some aspects of the literature analysis, In: Forest Ecosystems and Climate Changes, Belgrade (2010), 275-283.

Głowacki D., Orczyk T., Porwik P., The new rule based colour classifier in the problem of human skin colour detection, Journal of Medical Informatics & Technologies, vol.14, (2010), 39-48.

Hadjipanayi E., Ananta M., Binkowski M., Streeter I., Lu Z., Cui Z.F., Brown R.A., Mudera V., Mechanisms of Structure - Generation during Plastic Compression of Nanofibrillar Collagen

Hydrogel Scaffolds: Towards Engineering of Collagen, *Journal of Tissue Engineering and Regenerative Medicine*, article first published online : 9 DEC (2010), DOI: 10.1002/term.343.

Juszczuk P., Kłosowicz L., Comparative Study of Artificial Bee Colony and Differential Evolution, *Artificial Intelligence Methods: Selected Issues*, (2010), 25-38.

Gdawiec K., Pseudofractal 2D Shape Recognition, *Lecture Notes in Artificial Intelligence*, vol. 6401, (2010), 403-410.

Koprowski R., Wróbel Z., Nowińska A., Wylęgała E., Automatic measuring of the iridocorneal angle on the optical coherence tomographic image of the anterior segment of the eye, *Advances in Soft Computing 57 - Information Technologies in Biomedicine*, Springer (2010), 175-182.

Koprowski R., Wróbel Z., Zieleźnik W., Analysis of thyroid ultrasonogram in Hashimoto's disease., *Computer Applications and Computational Science*, IRST (2010), 448-451.

Koprowski R., Wróbel Z., Zieleźnik W., Automatic ultrasound image analysis in Hashimoto's disease, *LNCIS, Advances in Pattern Recognition*, Springer (2010), 98-106.

Koprowski R., Wróbel Z., Analysis of properties of algorithm for automatic analysis of areas on ultrasonograms in Hashimoto's disease, *Computer Applications and Computational Science*, IRST (2010), 452-455.

Kudłacik P., Advantages of an approximate reasoning based on a fuzzy truth value, *Journal of Medical Informatics & Technologies*, vol.16, (2010), 125-132.

Lamża A., Wróbel Z., The dynamics of the clusterization process in an adaptative method of image segmentation., *Advances in Soft Computing 57 - Information Technologies in Biomedicine*, Springer (2010), 25-32.

Lisowska A., Kaczmarzyk T., JCURVE - Multiscale Curve Coding via Second Order Beamlets, *Machine Graphics & Vision*, vol. 19, no. 3, (2010), 265-281.

Marzec M., Koprowski R., Wróbel Z., Detection of selected face areas on thermograms with elimination of typical problems, *Journal of Medical Informatics & Technologies*, vol. 16, (2010), 151-160.

Nowak – Brzezińska A., Xięski T., Jach T., Finding a relevant document in the clusters of documents' characteristics, *Intelligent Information Systems 2010*, Publishing House of University of Podlasie, ISBN 978-83-7051-580-5, (2010), 273–283.

Orczyk T., Porwik P., An attempt to improve eigenface algorithm efficiency for colour images, *Journal of Medical Informatics & Technologies*, vol.16, (2010), 201-208.

Orzechowski T., Dziech A., Wróbel Z., Information and communication technologies supporting education., *Monografia E-enjoy ICT Quality Book*, Zabrze (2010), 41-60.

Paszek P., Marszał-Paszek B., Deterministic and Nondeterministic Rules in Classification Process. *Journal of Medical Informatics & Technologies*, vol. 15, (2010), 87-102.

Porwik P., Conditions of the affine extension of an incompletely defined Boolean function, *Journal Computing and Informatics*, vol.29, (2010), 1001-1017.

Porwik P., *Journal of Medical Informatics & Technologies, Zakład Systemów Komputerowych, Katowice*, vol. 14, (2010), (ISSN 1642-6037) 48.

Porwik P., *Journal of Medical Informatics & Technologies, Zakład Systemów Komputerowych, Katowice*, vol. 15, (2010), (ISSN 1642-6037) 208.

Porwik P., *Journal of Medical Informatics & Technologies, Zakład Systemów Komputerowych, Katowice*, vol. 16, (2010), (ISSN 1642-6037) 208.

Porwik P., The modern techniques of latent fingerprint imaging. INVITED TALK. IEEE Int. Conf. on Computer Information and Industrial Management Applications. CISIM 2010, 29-33.

Porwik P., Doroz R., Wrobel K., A New Signature Similarity Measure Based on Windows Allocation Technique, *International Journal of Computer Information Systems and Industrial Management Applications (IJCISIM)*, vol. 2, (2010), ISSN 2150-7988, 297-305.

Porwik P., Proksa R., Endpoints detection level for isolated words recognition, in: *Monograph Biometry - Special Issue, Centrum Inżynierii Biomedycznej, Gliwice (2010)*, 53-68.

Porwik P., Więclaw Ł., Fingerprint ridges distance measurement from bitmap images, in: *Monograph Biometry - Special Issue, Centrum Inżynierii Biomedycznej, Gliwice (2010)*, 41-52.

Porwik P., Zyguła J., Doroz R., Proksa R., Biometric recognition system based on the motion of the human body gravity centre analysis, *Journal of Medical Informatics & Technologies*, vol.15,(2010), 61-70.

Sapota G., Sapota A., Wróbel Z., The use of Kalman filtration to estimate changes of trunk inclination angle during weightlifting, *Journal of Medical Informatics & Technologies*, vol. 15, (2010), 155-162.

Skadłubowicz P., Król A., Wróbel Z., Hefti F., Krieg A., Reconstruction of the pelvic region based on the statistical shape modeling., *Advances in Soft Computing 57 - Information Technologies in Biomedicine, Springer (2010)*, 165-172.

Smacki L., Porwik P., Tomaszycycki K., Kwarciańska S., The lip print recognition using Hough transform, *Journal of Medical Informatics & Technologies*, vol.14, (2010), 31-38.

Smacki Ł., Lip traces recognition based on lines pattern, *Journal of Medical Informatics & Technologies*, vol.15, (2010), 53-60.

Stach S., Wróbel Z., Methodology of examining fracture surfaces of biomaterials by means of modelling and multifractal analysis, *Advances in Soft Computing 57 - Information Technologies in Biomedicine*, Springer (2010), 431-438.

Styblińska M., Radio frequency identification – RFID technology – how far can we go, in: *Space, heritage and future*, Hrvatski Informatički Zbor – GIS Forum, University of Silesia, Zagreb, (2010), 154-160.

Wakulicz-Deja A., Przybyła-Kasperek M., Multi-Agent Decision Taking System, *Fundamenta Informaticae*, 101(1-2), (2010), 125-141.

Wieczorek W., A local search algorithm for grammatical inference, In *Proceedings of the 10th international colloquium conference on Grammatical inference: theoretical results and applications (ICGI'10)*, J. M. Sempere and Pedro Garcia (Eds.). Springer-Verlag, Berlin, Heidelberg, LNAI 6339, 217-229.

Wieczorek W., An algorithm for the decomposition of finite languages, *Logic Journal of the IGPL*, 18, 3, (June 2010), 355-366.

Więclaw Ł., Porwik P., The pixel alignment based algorithm for continuous orientation field estimation, *Journal of Medical Informatics & Technologies*, vol.15, (2010), 47-52.

Wróbel K., Doroz R., The method of signature recognition based on least squares contour alignment and windows technique, *Journal of Medical Informatics & Technologies*, vol.15, (2010), 35-40.

## **2011**

Alkhalid A., Amin T., Chikalov I., Hussain S., Moshkov M., Zielosko B., *Dagger*, A Tool for Analysis and Optimization of Decision Trees and Rules, *Computational Informatics, Social Factors and New Information Technologies: Hypermedia Perspectives and Avant-Garde Experiences in the Era of Communicability Expansion*, Blue Herons Editions, Bergamo, Italy, (2011), 29-39.

Amin T., Chikalov I., Moshkov M., Zielosko B., Dynamic programming algorithm for optimization of beta-decision rules, in: *Szczuka, M, Czaja, L., Skowron, A., Kacprzak, M. (eds.) 20th International Workshop Concurrency, Specification and Programming CS&P (2011)*, September 28-30, Pułtusk, Poland, Białystok University of Technology, 10-16.

Błazejowski B., Binkowski M., Bitner M. A., Gieszcz P., X-ray microtomography (XMT) of fossil brachiopod shell interiors for taxonomy, *Acta Palaeontologica Polonica*, (2011), 439-440.

Błocho, M., Czech, Z.J., A parallel algorithm for minimizing the number of routes in the vehicle routing problem with time windows, *9th International Conference on Parallel Processing and Applied Mathematics, LNCS*, (2011), 355-366.

Błocho, M., Czech, Z.J., An improved route minimization algorithm for the vehicle routing problem with time windows, *Studia Informatica*, 32, 3B(99), (2011), 5-19.

Boryczka U., Kozak J., An Adaptive Discretization in the ACDT Algorithm for Continuous Attributes. LNCS, vol. 6923, (2011), 475-484.

Boryczka U., Juszczuk P., Approximate Nash Equilibria in Bimatrix Games, LNCS, vol. 6923, (2011), 485-494.

Boryczka U., Kozak J., New insights of cooperation among ants in Ant Colony Decision Trees, Third World Congress on Nature & Biologically Inspired Computing, NaBIC 2011, Salamanca, Spain, October 19-21, 2011, IEEE (2011), 255-260.

Bura W., Boryczka M., The Parallel Ant Vehicle Navigation System with CUDA Technology. Computational Collective Intelligence, Technologies and Applications, LNCS, vol. 6923, (2011), 505-514.

Chikalov I., Moshkov M., Zielosko B., Online learning algorithm for ensemble of decision rules, in: Sergei O. Kuznetsov S.O., Ślęzak D., Hepting D.H., Mirkin B. (eds.) Rough Sets, Fuzzy Sets, Data Mining and Granular Computing - 13th International Conference, RSFDGrC 2011, Moscow, Russia, June 25-27, LNCS, vol. 6743, (2011), 310-313.

Chikalov I., Zielosko B., Decision rules for decision tables with many-valued decisions, in: Yao J., Ramanna S., Wang G., Suraj Z. (eds.) Rough Sets and Knowledge Technology - 6th International Conference, RSKT 2011, Banff, Canada, October 9-12, LNCS, vol. 6954, (2011), 763-768.

Doroz R., Porwik P., Handwritten signature recognition with adaptive selection of behavioral features 10th Int. Conf. on Computer Information Systems & Industrial Management Applications (CISIM), Calcutta, India, Springer-Verlag, (2011), vol. 245, 128-136.

Dramiński M., Kierczak M., Nowak-Brzezińska A., Koronacki J., Komorowski J., The Monte Carlo feature selection and interdependency discovery is unbiased, *Control and Cybernetics*, vol. 40, (2011), no. 2, 199-211.

Elpiniki I. Papageorgiou, Froelich W., Application of Evolutionary Fuzzy Cognitive Maps for Prediction of Pulmonary Infections, *IEEE Transactions on Information Technology in Biomedicine*, vol. 11, (2011), DOI: 10.1109/TITB.2011.2175937.

Froelich W., Wakulicz-Deja A., Probabilistic Similarity-Based Reduct, LNCS, vol. 6954, (2011), 610-615.

Gajos M., Bibliography of GIS – Supplement 2006-2010, *The Future with GIS*. D. Kereković (Ed.) Hrvatski Informatički Zbor – GiS Forum, Zagreb (2011), 213-226.

Gajos M., Research Directions of Polish-Croatian GIS Co-operation, *The Future with GIS*. D. Kereković (Ed.), Hrvatski Informatički Zbor – GiS Forum, Zagreb (2011), 235-242.



Gdawiec, K., Domańska, D., Partitioned Iterated Function Systems with Division and Fractal Dependence Graph in Recognition of 2D Shapes. *International Journal of Applied Mathematics and Computer Science* 21(4), (2011), 757-767.

Gdawiec K., Kotarski W., Lisowska A., Automatic Generation of Aesthetic Patterns with the Use of Dynamical systems, *LNCS*, vol. 6939, (2011), 691-700.

Koprowski R., Wróbel Z., Selected methods of image analysis in optical coherence tomography., *Matlab Book 1*, (2011), 501-522.

Kostorz I., Doroz R., On-line signature recognition based on reduced set of points, *Computer Recognition Systems 4, Advances in Intelligent and Soft Computing*, vol. 95, (2011), Springer-Verlag, 3-11.

Lisowska A., Edge Detection by Sliding Wedgelets, *LNCS*, vol. 6753, part 1, (2011), 50-57.

Lisowska A., Smoothlets - Multiscale Functions for Adaptive Representations of Images, *IEEE Transactions on Image Processing*, vol. 20, no. 7, (2011), 1777-1787.

Lisowska A., Moments-Based Fast Wedgelet Transform, *Journal on Mathematical Imaging and Vision*, Springer, vol. 39, no. 2, (2011), 180-192.

Marszał-Paszek B., P. Paszek, Nondeterministic Decision Rules in Classification Process for Medical Data, *Journal of Medical Informatics & Technologies*, vol. 17, (2011), 59-64.

Moshkov M., Zielosko B., Construction of  $\alpha$ -decision trees for tables with many-valued decisions. in: Yao J., Ramanna S., Wang G., Suraj Z. (eds.), *Rough Sets and Knowledge Technology - 6th International Conference, RSKT 2011, Banff, Canada, October 9-12, Proceedings*, LNCS vol. 6954, (2011), 486-494.

Moshkov M., Zielosko B., Construction of tests for tables with many-valued decisions, Szczuka, M., Czaja L., Skowron A., Kacprzak M. (eds.), *20th International Workshop Concurrency, Specification and Programming CS&P*, September 28-30, Pułtusk, Poland, Białystok University of Technology, (2011), 376-384.

Musialik-Swietlińska E., Wojaczyńska-Stanek K., Swietliński J., Koprowski R., Krawczyk R., Bober K., Thermal comfort in preterm babies, Infra-red colour thermography findings, Preliminary report, *Medycyna Wieku Rozwojowego, Developmental Period Medicine*, (2011) Jan-Mar; 15(1), 79-83.

Orczyk T., Pałys M., Porwik P., Musialik J., Błońska-Fajfrowska B., Simple and non-invasive liver fibrosis stage prediction method, *Journal of Medical Informatics & Technologies*, vol. 17, (2011), 227-231.

Orczyk T., Porwik P., Feature Based Face Detection Algorithm for Digital Still Images Image Processing and Communications Challenges 3, Advances in Intelligent and Soft Computing, vol. 102, Berlin, Heidelberg, (2011), 59-64.

Pałys M., Sablik M., Generalized Homogeneity of Means Mathematical Analysis, Hindawi Publishing Corporation, Article ID 202409, vol. 2011, (2011), 1-13.

Popielski P., Wróbel Z., An attempt to optimize the process of automatic point matching for homogeneous surface objects, Archiwum fotogrametrii, kartografii i teledetekcji, Archives of Photogrammetry, Cartography and Remote Sensing, (2011), 351-361.

Porwik P., Wesołowski T., Wróbel K., Sosnowski M., A Computational Assessment of a Blood Vessels Compliance: A Procedure Based on Computed Tomography Coronary Angiography, Lecture Notes in Artificial Intelligence, part I. Hybrid Artificial Intelligent Systems (LNAI 6678), Springer-Verlag, vol. 1 (2011), 428-435.

Porwik P., Wróbel K., Wesołowski T., Sosnowski M., The Attempt of The Blood Vessel Contractibility Estimation on The Basis of The Computed Tomography Imaging, Journal of Medical Informatics & Technologies, vol. 17, (2011), 173-181.

Simiński R., Nowak-Brzezińska A., Jach T., Xięski T., Towards a practical approach to discover internal dependencies in rule-based knowledge bases, Rough Sets and Knowledge Technology LNCS 6954, (2011), 232-237.

Skadłubowicz P., Król Z., Wróbel Z., Hefti F., Krieg A., Biometrical approach in the pelvis surgical reconstruction treatment, International Journal of Biometrics, vol. 3, no 1, (2011), 76-84.

Skinderowicz R., Co-operative, Parallel Simulated Annealing for the VRPTW, LNCS, vol. 6923, (2011), 495-504.

Smacki Ł., Wróbel K., Porwik P., Lip Print Recognition Based on DTW Algorithm, Third World Congress on Nature and Biologically Inspired Computing (NaBIC'11), Salamanca, Spain. IEEE Press, (2011), 601-606.

Smacki Ł., Wróbel K., Lip Print Recognition Based on Mean Differences Similarity Measure, Computer Recognition Systems 4, Advances in Intelligent and Soft Computing, vol. 95, Berlin, Heidelberg (2011), 41-49.

Stach S., The Simulation and Modelling of the Crack Path of Biomaterial., Key Engineering Materials, (2011), vol. 465, 141-144.

Stach S., Fractal Methods of Analysis of Biomaterial Surfaces, Key Engineering Materials, (2011), vol. 465, 276-281.

Stach S., Comparative Studies of Fracture Surfaces of a Biomaterial with the Use of a Profilographometer and Confocal Microscope, *Key Engineering Materials*, (2011), vol. 465, 271-275.

Styblińska M., Some Concerns about Nuclear Power Plants After Japanese Apocalypse, in: *The Future with GIS*. D. Kereković (Ed.), *Hrvatski Informatički Zbor – GIS Forum*, Zagreb 2011, Scientific Monograph, (2011), 104-112.

Wakulicz-Deja A., Przybyła-Kasperek M., Application of the method of editing and condensing in the process of global decision-making, *Fundamenta Informaticae*, vol. 106, no.1, (2011), 93-117.

Wakulicz-Deja A., Nowak-Brzezińska A., Jach T., Inference processes in decision support systems with incomplete knowledge, *Rough Sets and Knowledge Technology, Lecture Notes in Computer Science*, (2011), 616-625.

Wakulicz-Deja A., Nowak-Brzezińska A., Xięski T., Efficiency of complex data clustering, *Rough Sets and Knowledge Technology Lecture Notes in Computer Science, Kanada*, (2011), 616-625.

Wieczorek W., Skinderowicz R., Kozak J., Juszcuk P., New Trends in Clobber Programming, *ICGA Journal (International Computer Games Association Journal)*, vol. 34, no. 3, (2011), 150-158.

Więclaw Ł., Fingerprint Orientation Field Enhancement Computer Recognition Systems 4, *Advances in Intelligent and Soft Computing, Springer-Verlag* vol. 95., Berlin, Heidelberg (2011), 33-40.

Więclaw Ł., Fingerprint Directional Image Enhancement, *Lecture Notes in Computer Science Springer Verlag - LNCS* vol. 6540, (2011), 185-194.

Więclaw Ł., Orczyk T., Fingerprint ridges frequency. Third World Congress on Nature & Biologically Inspired Computing, *NaBIC 2011, Salamanca, Spain, IEEE Press*, (2011), 558-561.

Wróbel K., Doroz R., The method for finding a reference point in fingerprint images basing on an analysis of characteristic points, *Third World Congress on Nature and Biologically Inspired Computing (NaBIC'11), Salamanca, Spain, IEEE Press*, (2011), 504-508.

Van Garderen N., Clemens F.J., Kaufmann J., Urbanek M., Binkowski M., Graule T., Aneziris C.G., Pore analyses of highly porous diatomite and clay based materials for fluidized bed reactors, *Microporous and Mesoporous Materials*, vol. 151, (2011), 255-263.

## **2012**

Błocho, M., Czech, Z.J., A parallel algorithm for minimizing the number of routes in the vehicle routing problem with time windows, *9th International Conference on Parallel Processing and Applied Mathematics (PPAM 2012), LNCS*, vol. 7203, (2012), 255-265.

Boryczka U., Juszczuk P., A new evolutionary approach for computing Nash equilibria in bimatrix games with known support, *Central European Journal of Computer Science*, vol. 2, issue 2, (2012), 128-142.

Boryczka U., Juszczuk P., New Differential Evolution Selective Mutation Operator for the Nash Equilibria Problem, Nguyen N.T., Kiem H., Jedrzejowicz P. (eds.), *Computational Collective Intelligence. Technologies and Applications - 4th International Conference, ICCCI 2012, Ho Chi Minh City, Vietnam, November 28-30, 2012, Proceedings, Part II*, Springer, Berlin, (2012), 463-472.

Boryczka U., Juszczuk P., Solving the Sudoku with the Differential Evolution, *Zeszyty Naukowe Politechniki Białostockiej, Informatyka*, no 9, (2012), 5-16.

Boryczka U., Kozak J., Ant Colony Decision Forest Meta-ensemble, Nguyen, N.T., Hoang, K., Jedrzejowicz P., (eds.), *Computational Collective Intelligence. Technologies and Applications - 4th International Conference, ICCCI 2012, Ho Chi Minh City, Vietnam, November 28-30, 2012, Proceedings, Part II*, Springer, Berlin, 2012, 473-482.

Boryczka U., Strąk Ł. A., Hybrid Discrete Particle Swarm Optimization with Pheromone for Dynamic Traveling Salesman Problem, Nguyen N.T., Kiem H., Jedrzejowicz P. (eds.), *Computational Collective Intelligence. Technologies and Applications - 4th International Conference, ICCCI 2012, Ho Chi Minh City, Vietnam, November 28-30, 2012, Proceedings, Part II*, Springer, Berlin, 2012, 503-512.

Bura W., Boryczka M., Ant Colony Optimization for the Pareto Front Approximation in Vehicle Navigation, *Computational Collective Intelligence, Technologies and Applications, LNCS*, vol. 7654, (2012), 493-502.

Chodacki M., Badura D., Autonomous Test Structures for Synchronous Sequential Circuits, *IEEE International Carpathian Control Conference ICC 2012, Slovak Republic, Podbanske, 28-31 May, 2012*, 243-248.

Cybo J., Maszybrocka, J., Duda P., Bartczak Z., Barylski A., Kaptacz S., Properties of ultra-high-molecular-weight polyethylene with a structure modified by plastic deformation and electron-beam irradiation. *Journal of Applied Polymer Science* (2012), vol.125, Issue 6, 4197-4208.

Domańska D., Wojtylak M., Application of Fuzzy Time Series Models for Forecasting Pollution Concentrations, *Expert Systems with Applications* 39(9), (2012), 7673-7679.

Domańska D., Wojtylak M., Kotarski W., Visualization of Multidimensional Data in Explorative Forecast, *LNCS*, vol. 7594, (2012), 63-70.

Doroz R., Wróbel K., Dynamic Signature Recognition Based on Modified Windows Technique *Computer Information Systems and Industrial Management Conference, Venice, Italy, LNCS*, vol. 7564, (2012), 158-167.

Doroz R., Wróbel K., Using hidden Markov models in signature recognition process, *Journal of Medical Informatics & Technologies*, vol. 21, (2012), 75-84.

Elpiniki I. Papageorgiou, Froelich W., Application of Evolutionary Fuzzy Cognitive Maps for Prediction of Pulmonary Infections. *IEEE Transactions on Information Technology in Biomedicine*, 16(1), (2012), 143-149.

Elpiniki I. Papageorgiou, Froelich W., Multi-step prediction of pulmonary infection with the use of evolutionary fuzzy cognitive maps, *Neurocomputing*, 92, (2012), 28-35.

Froelich W., Elpiniki I. Papageorgiou, M.Samarinas, K. Skriapas, Application of evolutionary fuzzy cognitive maps to the long-term prediction of prostate cancer, *Applied Soft Computing*, 12(12) (2012), 3810-3817.

Froelich W., Mining Association Rules from Database Tables with the Instances of Simpson's Paradox, *Advances in Intelligent Systems and Computing*, vol. 186, (2012), 79-90.

Gajos M, Sierka E., GIS Technology in Environmental Protection: Research Directions Based on Literature Review. *Polish Journal of Environmental Studies*, 2(21), (2012), 241-248.

Gajos M., Geoinformation Technologies in Biomedicine and Health Care: Review of Scientific Journals., *Lecture Notes in Computer Science (Lecture Notes in Bioinformatics 7339 – Information Technologies in Biomedicine)* Springer 2012, 510-524

Gdawiec K., Domańska D., Recognition of Two-dimensional Shapes Based on Dependence Vectors, *Lecture Notes in Artificial Intelligence*, vol. 7267, Springer, (2012), 501-508.

Głogowska-Ligus J., J. Dąbek, E. Zych-Twardowska, Tkacz M., Expression analysis of intercellular adhesion molecule-2 (ICAM-2) in the context of classical cardiovascular risk factors in acute coronary syndrome patients, *Archives of Medical Science*, (2012), DOI:10.5114/aoms.2012.28808.

Janik P., Janik M.A., Wróbel Z., Micro-condensation sensor for monitoring respiratory rate and breath strength., *Sensors and Actuators A: Physical* 185 (2012), 160-167.

Koprowski R, Korzyńska A., Zieleźnik W., Wróbel Z., Małyszek J., Stępień B., Wójcik W., Influence of the measurement method of features in ultrasound images of the thyroid in the diagnosis of Hashimoto's disease, *BioMedical Engineering OnLine* (2012), 11:91 DOI:10.1186/1475-925X-11-91.

Koprowski R, Zieleźnik W., Wróbel Z., Małyszek J., Stępień B., Wójcik W., Assessment of significance of features acquired from thyroid ultrasonograms in Hashimoto's disease, *BioMedical Engineering OnLine* accepted in 2012, 11:48 DOI:10.1186/1475-925X-11-48.

Koprowski R., Teper S., Węglarz B., Wylęgała E., Krejca M., Wróbel Z., Fully automatic algorithm for the analysis of vessels in the angiographic image of the eye fundus, *BioMedical Engineering OnLine* (2012), DOI:10.1186/1475-925X-11-35.

Koprowski R., Teper S., Wylęgała E., Wróbel Z., Enhancing The Quality of Layer Detection in Tomographic Images of The Eye., *Lecture Notes in Computer Science (Lecture Notes in Bioinformatics 7339 – Information Technologies in Biomedicine)*. Springer 2012, 13-23.

Kotarski W., Gdawiec K., Lisowska A., Polynomiography via Ishikawa and Mann Iterations, *LNCS*, vol. 7431, (2012), 305-313.

Kudłacik P., Improving a Signature Recognition Method Using the Fuzzy Approach, *Journal of Medical Informatics & Technologies*, vol. 21, (2012), 85-94.

Kudłacik P., Performance Evaluation of Baldwin's Fuzzy Reasoning for Large Knowledge Bases, *Journal of Medical Informatics & Technologies*, vol.20, (2012), 29-38.

Kudłacik P., Porwik P., A new approach to signature recognition using the fuzzy method. *Pattern Analysis & Applications* (2012), 1-13.

Lamża A., Wróbel Z., A metropolitan assistive system for disabled and the elderly., *Lecture Notes in Computer Science (Lecture Notes in Bioinformatics 7339 – Information Technologies in Biomedicine)*, Springer 2012, 560-567.

Lamża A., Wróbel Z., New Ancient Method of Digital Video Stabilization for In-Car Camera., *Lecture Notes in Computer Science-Multimedia Communications, Services and Security*, Springer 2012, 183-190.

Nowak-Brzezińska A., Outlier mining in rule-based knowledge bases, *Rough Sets and Current Trends in Computing*, LNCS, vol. 7413, (2012), 206-211.

Nowak-Brzezińska A., Simiński R., Knowledge mining approach for optimization of inference processes in MEDICAL rule knowledge bases, *Journal of Medical Informatics & Technologies*, vol. 20, (2012), 19-27.

Nowak-Brzezińska A., Simiński R., Knowledge mining approach for optimization of inference processes in rule knowledge bases, P. Herrero et al. (Eds.): *OTM 2012 Workshops*, LNCS 7567, (2012), 534–537.

Orczyk T., Porwik P., Krawczyk B., Woźniak M., Musialik J., Błońska-Fajfrowska B., Classification techniques for non-invasive recognition of liver fibrosis stage, *Journal of Medical Informatics & Technologies*, vol. 20, (2012), 121-127.

Pałys M., Doroz R., Porwik P., The use of methods of statistical analysis in signature recognition system based on Levenshtein distance, *Journal of Medical Informatics & Technologies*, vol. 21, (2012), 67-74.

Paszek P., Marszał-Paszek B., Nondeterministic Decision Rules in Classification Process, On the Move to Meaningful Internet Systems: OTM 2012 Workshops, LNCS 7567, (2012), 485-494.

Popielski P., Wróbel Z., The Feature Detection on the Homogeneous Surfaces with Projected Pattern., Lecture Notes in Computer Science (Lecture Notes in Bioinformatics 7339 – Information Technologies in Biomedicine), Springer 2012, 118-128.

Porwik P., Orczyk T., DTW and Voting-Based Lip Print Recognition System (The best paper award), Computer Information Systems and Industrial Management Conference, Venice, Italy, LNCS, vol. 7564, (2012), 191-202.

Przybyła-Kasperek M., Wakulicz-Deja A., Application of decision rules, generated on the basis of local knowledge bases, in the process of global decision-making, Intelligent Decision Technologies Smart Innovation, Systems and Technologies, vol. 1, part 2, Springer, (2012), 375-388.

Skinderowicz R., Ant Colony System with Selective Pheromone Memory for TSP, Nguyen N.T., Kiem H., Jedrzejowicz P. (eds.), Computational Collective Intelligence. Technologies and Applications - 4th International Conference, ICCCI 2012, Ho Chi Minh City, Vietnam, November 28-30, 2012, Proceedings, Part II, Springer, Berlin , 2012, 483–492.

Van Garderen N., F. J. Clemens, J.Kaufmann, M. Urbanek, M. Binkowski, T. Graule, C. G. Aneziris, Pore analyses of highly porous diatomite and clay based materials for fluidized bed reactors, Microporous and Mesoporous Materials, 151 (2012), 255–263.

Wakulicz-Deja A., Nowak – Brzezińska A., Jach T., Inference processes using incomplete knowledge in Decision Support Systems – chosen aspects, Rough Sets and Current Trends in Computing, Lecture Notes in Computer Science, 2012,150-155

Waller T., Zapart D., Tkacz M, Wróbel Z., Analysis of Entity-Attribute-Value model applications in freely available database management systems for DNA microarray data processing, Journal of Medical Informatics & Technologies, vol. 17, (2012), 59-64.

Więclaw Ł., A review on fingerprint orientation estimation methods, Journal of Medical Informatics & Technologies, vol. 21, (2012), 95-102.

Wieczorek W., Induction of Non-Deterministic Finite Automata on Supercomputers, Journal of Machine Learning Research (JMLR), Workshop and Conference Proceedings, 21:237-242 (2012) [(ICGI 2012 Proceedings) Proceedings of the Eleventh International Conference on Grammatical Inference].

Wilczyński S., Pilawa B., Koprowski R., Wróbel Z., Ptaszkiewicz M., Swakoń J., Olko P., EPR studies of free radical decay and survival in gamma irradiated aminoglycoside antibiotics: sisomicin, tobramycin and paromomycin., European Journal of Pharmaceutical Sciences, 45 (2012), 251-262.

Wójcicka A., Wróbel Z., The panoramic visualization of metallic materials in macro- and microstructure of surface analysis using Microsoft Image Composite Editor (ICE) ., Lecture Notes in Computer Science (Lecture Notes in Bioinformatics 7339 – Information Technologies in Biomedicine), Springer 2012, 357-368.

Xięski T., Nowak-Brzezińska A., Wakulicz-Deja A., Density-based method for clustering and visualization of complex data. Rough Sets and Current Trends in Computing, Lecture Notes in Computer Science, (2012), 142-149.



### 3. Education

Education in computer science is organized into two stages: three-and-half-year engineer's and two-year master's studies. The similar system applies to vocational study schemes.

Education in biomedical engineering is organized into one stage: three-year engineer's studies.

Additionally, best graduates have a possibility to prepare their PhD thesis at the third level studies.

#### Undergraduate studies

At the undergraduate studies in computer science, besides computer and information systems, students receive a vast amount of knowledge on management, business, marketing, and about legal problems referring to widely understood economic activities. The program of studies provides students with sound bases of elementary discipline as well as practical skills indispensable to their future work.

Instruction is conducted in various forms with a particular regard to laboratory classes. Facilities in the laboratories give a possibility to acquire skills in using methods and tools of computer science. The program of studies contains the following blocks of courses:

- General education courses (mathematics, physics, electronics, foreign languages – West-European, informatics law),
- Courses in the field of information science basics (introduction to computer science, algorithms and data structures, fundamentals and programming languages),
- Courses in the field of information systems (databases, systems of information retrieval, expert systems, graphic interaction systems, computer systems design),
- Facultative courses for acquiring a particular vocational skill.

After the third semester year of studies students choose a specialization. The list of specializations to choose from is as follows (in parentheses some main courses within a faculty are given):

A. Engineer's studies in computer science:

a. Designer of intelligent applications (Specialized data bases and knowledge databases, Parallel programming, Advanced programming techniques),

b. Software engineering (Modern object-oriented languages, User-oriented design, Internet application design),

c. Engineering graphics (Interactive graphics, GUI design, Data visualization),

d. Computer management of innovative processes (Integrated information systems, Innovative activity, Legislative protection of innovation),

- e. Computer networks and mobile devices (Web environments and applications, Mobile device programming, Network infrastructure devices),
- f. Designer of web applications (Graphical web interfaces, Designing with Flash technology, Network Ajax applets).

Computer games programmer is a new speciality on Computer Science faculty (Introduction to game programming, Animation programming, Introduction to artificial intelligence and expert systems, Swarm intelligence systems, Physical processes simulation, Game theory, 3D modeling, Programming with DirectX, Introduction to HDR technology).

B. Engineer`s studies in biomedical engineering (Informatics in Medicine):

- a. Medical imaging (Medical Imaging Devices, Medical Images Analysing and Processing, Digitizing and 3D Analysis, Reconstruction in Medicine),
- b. Telemedicine and Hospital Information Systems (The Basis of Telecommunication, Medical Data Acquisition, Biomedical Data Bases),
- c. Biomedical mechatronics (Introduction to Mechatronics, Mechatronics in Rehabilitation, Medical Manipulators and Robots),
- d. Bioinformatics (The Basis of Biostatistics, Algorithms Complexity Analysis, Data Mining).

### **Postgraduate studies**

At the two-year master's studies students acquire knowledge on such problems as computer systems modeling and analysis, programming in integrated environments, image processing, operation systems design and application of computer systems to the automation of industrial processes as well as to data measurements. After the first semester of studies students choose a specialization.

The list of specializations to choose is the following (in parentheses some main courses within a faculty are given):

- a. Computer networks and software designer (Computer networks design, Networks data bases, Networks interfaces design),
- b. Information systems and intelligent systems (Information networks systems, Specialized expert systems, Data and knowledge protection),
- c. Software engineering (RIA Technology, Mobile systems and applications, Optimization techniques, Graphics and multimedia processing methods),
- d. Computer visualization systems (Multi-resolution image analysis, Geometrical modeling, Artificial intelligent methods),

e. Modern programming technics (Parallel programming, Modern object-oriented languages, Advanced methods of intelligent calculation),

f. Medical Informatics (Information systems in medicine, Bionics).

2-year Master's studies also give students the opportunity to choose from three specialties. The list of specialties is as follows:

a. Bioinformatics (Fundamentals of natural sciences, Introduction to bioinformatics, Artificial intelligent systems),

b. Data analyst (Statistical methods of data analysis, Learning systems, Methods and techniques of classification of objects).

c. BIEN - Modeling and Visualization in Bioinformatics - a new, innovative speciality of lectures in English (Introduction to Bioinformatics, Methods of data analysis, Graphical methods to model bioinformatics problems, Artificial intelligence, Knowledge discovery, Mathematical statistics, Database design, Programming, Optimization theory, Simulation and visualization methods).

In the final study year students prepare their master's theses and on passing master's examination they are granted the master's degree in computer science.

Applicants for admission to these studies must hold a licentiate's title in computer science (or its equivalent).

### **PhD studies**

Institute of Computer Science since 2007 offers four-year studies of the third level (PhD), which ends up granting the degree of PhD of technical sciences in the field of Computer Science. Students prepare a doctoral thesis under the guidance of an academic supervisor coordinating their research.

During these studies, students gain knowledge and skills in mathematics (e.g. discrete mathematics, probability calculus and mathematical statistics), computer science (e.g. parallel algorithms, artificial intelligence, computer networks, image processing, security systems) and additional courses (methodology research, intellectual property protection). Students have also the opportunity to choose optional courses from 20 proposals. For each year of study they may apply for different types of scholarships, both from the university (for the best student, doctoral, quality-supplement) as well as from other sources (e.g. EU projects).

## 4. Staff

### 4.1. Professors

**Mariusz Boryczka** (e-mail: [mariusz.boryczka@us.edu.pl](mailto:mariusz.boryczka@us.edu.pl))

**Ph.D.:** Application of the rough sets theory to the optimization of decision tables and to the analysis of multicriteria decision problems.

**Habilitation:** Ant colony programming in the process of the automatic approximation of functions.

**Position:** Associate professor.

**Main fields of research interest:**

Artificial intelligence, evolutionary computation, optimization, automatic programming.

**Selected publications:**

1. Boryczka M., Ant colony programming with the candidate list, in: Agent and Multi-Agent Systems: Technologies and Applications, LNCS, vol. 4953, (2008), 302–311.
2. Boryczka M., Ant Colony Programming: Application of Ant Colony System to Function Approximation, Chapter 11 in: Intelligent Systems for Automated Learning and Adaptation: Emerging Trends and Applications, IGI Global, (2009), 248–272.
3. Bura W., Boryczka M., Ant colony system in ambulance navigation, Journal of Medical Informatics & Technologies, vol. 15, (2010), 115-124.
4. Bura W., Boryczka M., The Parallel Ant Vehicle Navigation System with CUDA Technology, Computational Collective Intelligence. Technologies and Applications, LNCS, vol. 6923, (2011), 505-514.
5. Bura W., Boryczka M., Ant Colony Optimization for the Pareto Front Approximation in Vehicle Navigation, in: N. Nguyen, K. Hoang and P. Jędrzejowicz (eds): Computational Collective Intelligence, Technologies and Applications, LNCS, vol. 7654, (2012), 493-502.

**Urszula Boryczka** (e-mail: [urszula.boryczka@us.edu.pl](mailto:urszula.boryczka@us.edu.pl))

**Ph.D.:** Automatic recognition of linguistic categories of words for scientific-technical information retrieval.

**Habilitation:** Algorithms of the ant colony optimization.

**Position:** Associate professor.

**Main fields of research interest:**

Artificial intelligence, swarm intelligence, data mining, optimization techniques.

**Selected publications:**

1. Boryczka U., Ants in Web Searching Process, P. S. Szczepaniak et al (Eds), Springer, Lecture Notes in Artificial Intelligence, vol. 3528, (2005), 57-62.
2. Boryczka U., Finding groups in data: cluster analysis with ants, Applied Soft Computing Journal 9, Elsevier, (2008), 61-70.

3. Boryczka U., Juszczuk P., Approximate Nash Equilibria in Bimatrix Games, LNCS, vol. 6923, (2011), 485-494.
4. Boryczka U., Kozak J., An Adaptive Discretization in the ACDT Algorithm for Continuous Attributes, LNCS, vol. 6923, (2011), 475-484.
5. Boryczka U., Kozak J. Ant Colony Decision Forest Meta-ensemble, Nguyen, N.T., Hoang, K., Jędrzejowicz P., (eds.), Computational Collective Intelligence. Technologies and Applications - 4th International Conference, ICCCI 2012, Ho Chi Minh City, Vietnam, November 28-30, Proceedings, Part II, Springer, Berlin, (2012), 473-482.

**Zbigniew J. Czech** (e-mail: zbigniew.czech@us.edu.pl)

**Ph.D.:** Operating systems and languages for sequential control.

**Habilitation:** A region analysis algorithm for the data flow analysis problems.

**Position:** Professor.

**Main fields of research interest:**

Design and analysis of serial and parallel algorithms, parallel computing, discrete optimization problems.

**Study visits:**

University of York, Great Britain (1983-84), University of California, Santa Barbara, U.S.A. (1988), Indiana-Purdue University, Indianapolis (1988-89), University of Queensland, Australia (1994), University of Kent, Canterbury, Great Britain (1995).

**Selected publications:**

1. Czech Z.J., Co-operation of processes in parallel simulated annealing, Proc. of the 18th IASTED International Conference on Parallel and Distributed Computing and Systems, Dallas, Texas, USA, (November 13-15, 2006), 401-406.
2. Czech Z.J., Statistical measures of a fitness landscape for the vehicle routing problem, Proc. of the 22nd IEEE International Parallel and Distributed Symposium (IPDPS 2008), 11th Intern. Workshop on Nature Inspired Distributed Computing (NIDISC 2008), Miami, Florida, USA, 1-8.
3. Czech, Z.J., A parallel simulated annealing algorithm as a tool for fitness landscape exploration, In: Ros, A., (ed.), Parallel and Distributed Computing, In-Tech, Vukovar, Croatia, (2010), chapter 13, 247-271.
4. 4. Błocho, M., Czech, Z.J., A parallel EAX-based algorithm for minimizing the number of routes in the vehicle routing problem with time windows, Proc. 2012 IEEE 14th International Conference on High Performance Computing and Communications, Liverpool, UK, 25-27 June (2012), 1239-1246.
5. Czech, Z.J., Wprowadzenie do obliczeń równoległych, PWN, Warszawa (2013), nowe wydanie.

**Wiesław Kotarski** (e-mail: kotarski@ux2.math.us.edu.pl)

**Ph.D.:** Application of conical approximations to optimal control problems for parabolic systems.

**Habilitation:** Some problems of optimal and Pareto optimal control for distributed parameter systems.

**Position:** Professor.

**Main fields of research interest:**

Optimal control theory, multicriterial optimization, applications of computer algebra systems (MAPLE V) to simulation, fractal modeling and image theory.

**Study visits:**

Stefan Banach International Mathematical Center, Warsaw, Poland (1980), International Centre for Theoretical Physics, Trieste, Italy (1985), The African University, Aswan, Egypt (1990), The Fields Institute, Waterloo, Canada (1992).

**Selected publications:**

1. Kotarski W., El-Saify H.A., Optimality of the boundary control for  $n \times n$  parabolic lag system, *Journal of Mathematical Analysis and Applications*, vol. 319, (2006), no. 1, 61-73.
2. Kotarski W., *Fraktalne modelowanie kształtu*, Wydawnictwo EXIT, Warszawa, (2008), 1-206.
3. Kotarski W., Gdawiec K., Machnik G.T., *Basics of Modelling and Visualization*, University of Silesia, Katowice, (2009), 1-110 + CD.
4. Gdawiec K., Kotarski W., Lisowska A., *Automatic Generation of Aesthetic Patterns with the Use of Dynamical Systems*, LNCS, vol. 6939, (2011), 691-700.
5. Kotarski W., Gdawiec K., Lisowska A., *Polynomiography via Ishikawa and Mann Iterations*, LNCS, vol. 7431, (2012), 305-313.

**Piotr Porwik** (e-mail: piotr.porwik@us.edu.pl)

**Ph.D.:** Utilization of the Walsh functions in diagnostics of digital devices.

**Habilitation:** Orthogonal transforms for binary data features extraction.

**Position:** Associate professor.

**Main fields of research interest:**

Spectral and discrete representations of multiple-valued and binary functions, digital logic design, digital signal and image processing, biometrics and biomedical imaging.

**Selected publications:**

1. Porwik P., Conditions of the affine extension of an incompletely defined Boolean function. *Computing and Informatics* vol.29, (2010), 1073-1088.
2. Porwik P., Sosnowski M., Wesółowski T., Wróbel K. A Computational Assessment of a Blood Vessel's Compliance: A Procedure Based on Computed Tomography Coronary Angiography, HAIS 2011. *Lecture Notes in Artificial Intelligence. Part I.* Springer-Verlag, (2011), 428-435.

3. Doroz R., Porwik P., Handwritten signature recognition with adaptive selection of behavioral features, 10<sup>th</sup> Int. Conf. on Computer Information Systems & Industrial Management Applications CISIM Calcutta, India, Springer-Verlag, (2011), 128-136.
4. Porwik P., Orczyk T., DTW and voting-based lip print recognition system. 11th Int. Conf. on Information Systems and Industrial Management Venice, Italy, September 26-28, (2012), 191-202 (The best paper award).
5. Kudłacik P., Porwik P., A new approach to signature recognition using the fuzzy method, Pattern Analysis and Applications, (2012), 1-12, DOI 10.1007/s10044-012-0283-9.

**Alicja Wakulicz-Deja** (e-mail: alicja.wakulicz-deja@us.edu.pl)

**Ph.D.:** List instructions analysis in the concept of generic machine.

**Habilitation:** Foundations of information retrieval systems. Analysis of methods.

**Position:** Professor.

**Main fields of research interest:**

Expert systems, support systems for decision process, application of the rough sets theory.

**Selected publications:**

1. Wakulicz-Deja A., Przybyła-Kasperek M., Multi-Agent Decision Taking System, Fundamenta Informaticae 101(1-2), (2010), 125-141.
2. Froelich W., Wakulicz-Deja A., Medical diagnosis support by the application of associational fuzzy cognitive maps, Control and Cybernetics, 39(2), (2010).
3. Froelich W., Wakulicz-Deja A., Probabilistic Similarity-Based Reduct, LNCS, vol. 6954, (2011), 610-615.
4. Wakulicz-Deja A., Przybyła-Kasperek M., Application of the method of editing and condensing in the process of global decision-making, Fundamenta Informaticae 106 (1), 2989 Fundamenta Informaticae, (2011), 93-117.
5. Wakulicz-Deja A., Nowak-Brzezińska A., Jach T., Inference processes using incomplete knowledge in Decision Support Systems – chosen aspects. Rough Sets and Current Trends in Computing, Lecture Notes in Computer Science, (2012), 150-155.

**Zygmunt Wróbel** (e-mail: zygmunt.wrobel@us.edu.pl)

**Ph.D.:** Electrical properties of solid solution of Pb (Zr<sub>x</sub> Ti<sub>1-x</sub>)O<sub>3</sub>.

**Habilitation:** Synthesis of passive canonical structure in analogue electronic circuits.

**Position:** Professor.

**Main fields of research interest:**

Computer analysis and biomedical signal and image processing, biomedical engineering computer systems.

**Selected publications:**

1. Janik P., Janik M. A., Wróbel Z., Micro-condensation sensor for monitoring respiratory rate and breath strength, Sensors and Actuators A: Physical 185, (2012), 160-167.

2. Koprowski R., Teper S., Węglarz B., Wylegała E., Krejca M., Wróbel Z., Fully automatic algorithm for the analysis of vessels in the angiographic image of the eye fundus., BioMedical Engineering OnLine 2012.
3. Koprowski R., Zieleźnik W., Wróbel Z., Małyszczek J., Stępień B., Wójcik W., Assessment of significance of features acquired from thyroid ultrasonograms in Hashimoto's disease, BioMedical Engineering OnLine in 2012.
4. Koprowski R., Korzyńska A., Zieleźnik W., Wróbel Z., Małyszczek J., Stępień B., Wójcik W., Influence of the measurement method of features in ultrasound images of the thyroid in the diagnosis of Hashimoto's disease, 11:91, BioMedical Engineering OnLine 2012.
5. Wilczyński S., Pilawa B., Koprowski R., Wróbel Z., Ptaszkiewicz M., Swakoń J., Olko P., EPR studies of free radical decay and survival in gamma irradiated aminoglycoside antibiotics: sisomicin, tobramycin and paromomycin., European Journal of Pharmaceutical Sciences, 45, (2012), 251–262.

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