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Editor

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Preface

It is my pleasure to present you the proceedings of The Fifth International Workshop on Computer Modeling and Intelligent Systems (CMIS-2022), held in Zaporizhzhia, Ukraine on 12 of May 2022.

The CMIS workshop was held in 2022 for the fifth time at the National University "Zaporizhzhia Polytechnic" (<http://www.zp.edu.ua>), which is the largest and oldest regional center for science and higher education in the Zaporizhzhia region of South-Eastern Ukraine.

The Fifth International Workshop on Computer Modeling and Intelligent Systems is devoted to the 20-th Anniversaries of the foundation of the Faculty of Computer Science and Technology and the Department of Software Tools of the National University "Zaporizhzhia Polytechnic".

The Faculty of Computer Science and Technology traces its history back to the Faculty of Radio Engineering, where computer specialties were opened in the 1990s (1991 - "Computer Software and Automated Systems", 1992 - "Computer Systems and Networks", 2000 - "Specialized Computer Systems"). A new Faculty of Informatics and Computer Technology was established in 2002, and headed by the Dean, Associate Professor, Ph.D M. Kasian. The new faculty contained three new departments: Department of Software Tools, Department of Computer Systems and Networks, and Department of Computational Mathematics. In 2004 the specialty "Systems Analysis and Management" was opened, and the Department of Computational Mathematics was renamed as the Department of Systems Analysis and Computational Mathematics. Today, the faculty trains bachelors and masters in four specialties: 121 "Software Engineering", 122 "Computer Science", 123 "Computer Engineering" and 124 "Systems Analysis". Doctors of philosophy are prepared in two specialties: 122 "Computer Science", and 124 "Systems Analysis". Over the years of existence of the faculty's specialties, more than three thousand graduates of IT specialties have graduated.

The Department of Software Tools is the biggest IT department in Zaporizhzhia region and the biggest department in the University by the number of students. The history of the Software Tools Department begin in 1991, when, the specialty "Software for Computer Engineering and Automated Systems" was opened for the first time in the Zaporizhzhia region on the basis of the Department of Design and Production of Radio Electronic Equipment at the Vlas Chubar Zaporizhzhia Machine-Building Institute (later Zaporizhzhia State Technical University, then Zaporizhzhia National Technical University, now is the National University "Zaporizhzhia Polytechnic"). The founders of the specialty and IT education at University in the 1990s were Associate Professors V. Kryshchuk, S. Kornienko, M. Vasylega, V. Vysochyn, V. Dubrovin, V. Lebid', V. Onyshchenko, O. Petryshchev, G. Polyansky, V. Rysikov, S. Serdyuk, E. Tkachev, Senior Lecturers I. Levada, T. Onikienko, Assistant Professors O. Pozdnyakov, O. Stepanenko, L. Romanova (Deinega), S. Mylynchuk, L. Skachko and others. The employees of other departments were also involved in teaching at the department: Associate Professor V. Pinchuk, Associate Professor V. Tomashevs'ky, Senior Lecturers B. Soldatov, A. Markin and others. The specialty

was licensed and subsequently accredited thanks to the efforts of the teaching staff. In 1996, the first graduation of specialists with the qualification of "Software Engineer" took place.

Then there was a change in the name of the specialty: it became known as "Automated Systems Software" (ASS). On the basis of the ASS specialty, in 2000 the specialization "Software in business, management and entrepreneurship" was introduced. In 2002, a new Department of Software Tools was created, which became the basis for the specialty ASS and became part of the newly formed Faculty of Informatics and Computer Engineering (now it is the Faculty of Computer Science and Technologies). From the beginning of its creation and until 2012, the department was headed by Associate Professor, Ph.D A. Prytula. In 2004, a new specialty "Information Technologies of Design" (ITD) was opened at the department. In 2006-2009 the Department of Software Tools firstly in the University participated in Tempus project for joint Master Degrees in Software Engineering with Polish, Czech and German universities. This was a start of further massive work on internationalization at the department and in the University. In the 2000s, the department experienced a rapid expansion of the teaching staff: representatives of production (Senior Teacher A. Vasylenko) and young teachers (A. Parkhomenko, H. Nelasa, G. Shylo, G. Tabunshchyk, S. Subbotin, N. Myronova, M. Andreev, M. Kalinina, Zh. Kamins'ka, Ye. Fedorchenko, O. Kachan, A. Oliinyk). The teachers from other departments was also involved to the work of the Department of Software Tools (Assoc. Prof., Ph.D K. Kasian, Assoc. Prof., Ph.D R. Kudermetov and others). The technical staff (M. Andreev, M. Kalinina, L. Zonova, Ya. Zhornyk, O. Kavins'ka, and O. Ryashchenko) helped in ensuring the department's educational process.

From 2011 to 2016, the department was headed by Professor, Ph.D V. Dubrovin. There was a change in the name of the specialty ASS: it became known as "Software of Systems" (SS). In the 2010s, the new teachers (O. Oliinyk, Ye. Gofman, S. Zaitsev, V. Liovin, T. Fedoronchak, T. Kolpakova, T. Zaiko) starting work at the department. In this period the technical staff of the department was extended by new people (K. Ludvikevich, O. Goloviznin, V. Ryabets). In 2012, the specialties "Software Engineering" (SE) and "Artificial Intelligence Systems" (AIS) were opened at the department. Two new laboratories have been created at the department: the laboratory "CAD / CAM / CAE" (2012) and the laboratory "Embedded systems and remote engineering" (2015).

In 2014, for the first time, an employee of the department (S. Subbotin) defended his doctoral habilitation dissertation (the scientific consultant is Prof. D. Piza).

In 2015, according to the new list of specialties, a transition was made to training students in the specialties 121 "Software Engineering" (combines the specialties of SE and SS) and 122 "Computer Science" (combines the specialties of ITD and AIS).

In 2015, the team of students of the Software Tools Department took the first absolute place in the final table of the semi-finals of the world of the ACM Student Programming Contest in South-East Europe and the first absolute place in the final table of the final of the Ukrainian Championship in programming ACM in the major league.

Since 2016, the department has been headed by a former graduate of the department, Doctor habilitated of Science, Professor S. Subbotin. In autumn 2016, the Department of Software Tools expanded the licensed recruitment of Master's students to 150 people in total. In 2016, in the spring, the department licensed postgraduate studies for the preparation of Doctors of Philosophy (Ph.D) in the specialty 122 "Computer Science". In May 2016, a team of students of the department represented Ukraine in the finals of the International ACM Student Programming Contest in Thailand. In the 2018-19 academic year, the department successfully passed the accreditation of bachelor's and master's programs in both specialties 121 "Software Engineering" and 122 "Computer Science".

Each year from 2016 to 2021 the Department of Software Tools became a leader on the recruitment of applicants at the university (both in terms of the number of applications and the number of recruited students). In the 2021-2022 academic year, the number of students of the department reached 850 people, which is the largest number of students in the history of the department, and the department itself became the largest in terms of the number of students in the university and in the region.

For the period 2016-2021 the department has twice increased the number of lecture audiences assigned to it. The new laboratories of "Intelligent Computing, Virtual and Augmented Reality" and "Software Engineering" have been created at the department. The number of computer classes and laboratories has increased by 1.75 times. All classrooms and laboratories of the department were repaired and equipped with new furniture, air conditioners and multimedia projectors.

In 2021, two applicants for the Department of Software Tools (A. Oliinyk, M. Polyakov) has defended their dissertations for doctoral habilitation (the scientific consultant is S. Subbotin).

More than two thousand graduates of full-time, part-time and postgraduate forms of education at the levels of "bachelor", "specialist" (engineer), and "master" have been prepared on specialties of the Department of Software Tools over the years of existence in the University. They work at the enterprises of the Zaporizhzhia region, Ukraine and abroad.

Today, among the department's staff and external staff involved to the department's work there are three Doctors habilitated of Sciences (S. Subbotin, A. Oliinyk, M. Polyakov) and 21 Ph.Ds (O. Gladkova, T. Golub, Ye. Gofman, V. Dubrovin, T. Zaiko, I. Zeleneva, A. Kazurova, T. Kaplienko, M. Kasian, T. Kolpakova, S. Kornienko, M. Kotsur, V. Liovin, A. Parkhomenko, S. Serdyuk, S. Skrupsky, O. Stepanenko, G. Tabunshchik, E. Tereshchenko, T. Fedoronchak, O. Shytikova). Four employees have the academic title of Professor (S. Subbotin, A. Oliinyk, V. Dubrovin, G. Tabunshchik), 16 employees have the academic title of Associate Professor (T. Zayko, I. Zeleneva, A. Kazurova, T. Kaplienko, M. Kasian, T. Kolpakova, S. Kornienko, M. Kotsur, V. Liovin, A. Parkhomenko, M. Poliakov, S. Serdyuk, S. Skrupsky, A. Stepanenko, E. Tereshchenko, T. Fedoronchak). There are three Senior Lecturers (L. Deinega, O. Kachan, Ye. Fedorchenko), seven Assistant Professors (Ya. Zalubovsky, A. Timenko, D. Kavrin, Zh. Kamins'ka, O. Korotky, S. Leoshchenko, A. Tulenkov), three Heads of laboratories (M. Andreev, M. Kalinina, T. Kashina), three Senior Laboratory Assistants (A. Belova, V. Kostyuk, Ye. Vinnyk),

two Laboratory Assistants (S. Liovkina, E. Polyansky), and one Engineer (R. Shloma) working at the Department of Software Tools. The postgraduate students are also involved in the educational process at the department.

The department has two multimedia lecture rooms and seven modern computer laboratories and classrooms equipped with unique valuable equipment obtained through international and national educational and scientific projects. The material and technical base, educational, methodological and information support are updated annually.

The teachers of the department carry out significant educational, methodological and research work. The department carried out research work under the guidance of Professor S. Subbotin, Professor V. Dubrovin, Professor G. Tabunshchyk, Associate Professor V. Liovkin, and others. The main areas of scientific activity of the department staff are intelligent decision support systems and mathematical modeling in the problems of technical and biomedical diagnostics, in particular, based on artificial neural and neuro-fuzzy networks, using digital signal and image processing methods, methods optimization. Programming of intelligent embedded and robotic systems has become a new area of research in recent years. During the period of existence of the specialties of the department, its employees, graduate students and students took part in the implementation of more than thirty research projects.

The training of scientific and pedagogical personnel is an integral part of the work of the department, in which much attention is paid to the training of the young generation of scientists. Since 2016, a full-time postgraduate course has been operating at the Department of Software Tools for the preparation of Doctors of Philosophy (Ph.D) in specialty 122 "Computer Science" (Guarantor of the specialty is S. Subbotin). In previous years, Post-graduate students and applicants of the department prepared dissertations in the following specialties: 05.13.06 - information technology, 05.13.03 - systems and processes of control, 05.13.23 - systems and means of artificial intelligence, etc. During the existence of the department since 2002, the alumni of specialties, staff, post-graduate students and applicants of the Department of Software Tools defended four doctoral habilitation dissertations (S. Subbotin, A. Oliinyk, M. Polyakov, G. Shylo) and eighteen Ph.D thesis (G. Tabunshchyk, S. Subbotin, T. Kiprich, A. Stepanenko, A. Oliinyk, O. Oliinyk, O. Shitikova, T. Zaiko, V. Liovkin, T. Fedoronchak (Yur), Ye. Gofman, G. Nelasa, T. Kapliencko, A. Sogorin, N. Myronova, T. Kolpakova, K. Vodolazkina, Yu. Tverdokhlib).

For the scientific work "Methods and algorithms for the synthesis of neural network diagnostic and predictive models" S. Subbotin was awarded by the 2004 Prize of the President of Ukraine for young scientists by Decree of the President of Ukraine No. 1451/2004 dated 9.12.2004 on the basis of the submission of the Committee on State Prizes of Ukraine in the field of science and technology. For the work "Progressive technologies and software for modeling, optimization and intelligent automation of the manufacturing and operation of new generation aircraft engine parts" in 2010 S. Subbotin and A. Oliinyk was awarded by the Prize of the Parliament of Ukraine in the field of fundamental and applied research and scientific and technical developments (Resolution of the Parliament of Ukraine No. 2876-VI of December 23, 2010). S. Subbotin (in 2001), G. Tabunshchyk (in 2006), A. Oliinyk (in 2009), and O. Oli-

inyk (in 2010) were awarded by stipendiums from the Cabinet of Ministers of Ukraine.

Teachers, graduate students and students of the department take part in international, all-Ukrainian and university scientific and scientific-practical seminars, conferences, and schools. During the existence of the department since 2002, the teachers of the department have prepared and published more than thirty scientific monographs and educational textbooks, published more than a thousand articles in scientific journals and papers at conferences and workshops, received dozens of Ukrainian patents and certificates of copyright registration for computer programs.

The department annually hosts an international scientific workshop "Computer Modeling and Intelligent Systems", which papers are indexed by the Scopus scientometric database, and provides the editorial work of the scientific journal "Radio Electronics, Computer Science, Control", indexed by the Web of Science scientometric database and included in the lists of scientific professional periodicals of Ukraine (the highest category "A") and Poland.

Students of the department engaged in scientific work, under the guidance of teachers, take part and win prizes at university, regional and all-Ukrainian Olympiads and competitions of scientific works, make presentations at seminars and conferences. In particular, at the All-Ukrainian competition for the best scientific work in the nomination "Informatics" (2006, Sevastopol), the student An. Oliinyk (supervisor S. Subbotin) won. Students A. Oliinyk, Ye. Kuznetsov, O. Oliinyk, D. Nezhevenko, C. Boichenko, G. Ivanov, A. Larionov, and D. Panin have been winners of different years of regional competitions of the Zaporizhzhia Regional State Administration for gifted youth and are awarded with prizes and diplomas (supervisor is S. Subbotin). Student I. Lymarev have been the winner of the regional (2018, supervisor is S. Subbotin) and two all-Ukrainian competitions (2018, supervisor is V. Dubrovin; 2019, supervisor is S. Subbotin) for the best student research work.

The department is doing a lot of work to prepare university students for participation in programming contests, including the ACM / ICPC World Command Programming Championship, which is the largest student programming competition. Classes with students in different years were conducted by G. Tabunshchik, S. Subbotin, G. Nelasa, N Myronova, O. Kachan, L. Deynega, Zh. Kamins'ka. The most outstanding results are: the victory in the II stage (Southern region) and reaching the semi-final of the world student programming ACM-ICPC Olympiad, the Final of Ukraine in the Major league in 2013, 3rd place in the Final of Ukraine in 2012, 1-3 places at the regional stage (annually in different years), III place at the KPI-OPEN Olympiad in 2014.

Young scientists of the department are actively involved in the work of the Council of Young Scientists and Specialists of the University. At present, the Council is headed by post-graduate student S. Leoshchenko, earlier the council was headed by S. Subbotin.

The department pays considerable attention to cooperation with leading foreign and Ukrainian partners: Vimeo (Livestream), SoftServe, Noosphere, Freshcode, Computools, QATestLab, Light IT, Group BWT, Extrums, Infocom ltd, PowerCode, CHI Software, InCode, Kozak Group, Squro, Natife, Apriorit, Multinetworks srl, MPA

Group srl, AP Consulting, Ukrosoft, Open Geeks Lab, CookieDev, S-Pro, Absolute Web, DoneIT, Drum`N`Code, Koitechs, Logix ITS, Lumighost, Revolut ltd., Rezet, Uran, Urich, Upwork, Behance, Boosta, Zakaz.ua, 4DPipeline, Affiliate Dragons, Albedo, Alvakos, BestWebSoft, Binance, Coinmarket, CubeX, CUDEV, DataXDev, Digital Sight, DnC, Evernetica, GBKSOFIT, Koitechs, Magora Systems , Mobidev, Neosight, Phonexa, Pitch, Qwerty Software, SquadMind, Svitla Systems, Visartech, Volta, Weetteam, WhiteBit, X-Torus, Carlsberg Ukraine, ZalK, DTEK, Iskra, Zaporizhstal, Motor Sich, Privat Bank, UkrGrafrit, etc., on the basis of which students of the department undergo internships and alumni of the department are employed. A wide variety of enterprises where students train and graduates work indicates a high demand in the labor market for specialists in the specialties of the Software Tools Department and the opportunity for students of the department to easily find work in the region, in the country, and worldwide.

The Department of Software Tools together with the Public Organization "Ecosens" and the Public Organization "Foundation for Educational and Scientific Initiatives" are working to attract schoolchildren of the city of Zaporizhzhia to scientific work and further education at the university within the framework of the "SmartKids School of Robotics and Programming". Teachers of the department actively participate in the "Night of Science" and "Open Day" of the university.

The department participates in educational projects of the international programs Tempus and Erasmus+ of the European Union: "Cross-domain competencies for healthy and safe work in the 21st century" (Ref. No. 619034-EPP-1-2020-1-UA-EPPKA2-CBHE-JP, 2021-2023), "Innovative Multidisciplinary Curriculum in Artificial Implants for Bio-Engineering Bsc/Msc Degrees" (Ref. No. 586114-EPP-1-2017-1-ES-EPPKA2-CBHE-JP, 2017-2020), "Internet of Things: Emerging Curriculum for Industry and Human Applications" (Ref. No. 573818-EPP-1-2016-1-UK-EPPKA2-CBHE-JP, 2016-2019), "Centers of Excellence for Young Researchers" (Ref. No. 544137-tempus-1-2013-1-sk-tempus-jphes, 2013-2017), "Development of Embedded System Courses with implementation of Innovative Virtual approaches for Integration of Research, Education and Production in UA, GE, AM" (Ref. No. 544091-tempus-1-2013-1-be-tempus-jpcr, 2013-2016), "Industrial Cooperation and Creative Engineering Education based on Remote Engineering and Virtual Instrumentation" (Ref. No. 530278-tempus-1-2012-1-de-tempus-jphes, 2012-2015), "Practice-Oriented Master Programs in Engineering in Russia, Uzbekistan and Ukraine" (Ref. No. 510920-tempus-1-2010-1-de-tempus-jpcr, 2010-2013), "EU-UA Master Degree in Software Engineering" (Ref. No. JEP_26182_2005, 2006-2009), DAAD project "Virtual Master Cooperation Data Science", as well as Erasmus+ KA1 academic mobility (Belgium, Germany, Romania, Spain, Poland, Czech Republic, Austria) and DAAD (Germany). This makes it possible to improve the qualifications of the teachers of the department, who underwent internships at leading universities in Europe and the world, to prepare curricula and courses in accordance with world requirements, to receive the latest computer laboratory equipment, as well as licensed software.

The main purpose of the CMIS-2022 workshop is a discussion of the recent research results in all areas of Computer Sciences and Information Technologies.

The workshop is soliciting literature review, survey and research papers including, whilst not limited to, the following areas of interest:

- Artificial Intelligence (Pattern Recognition, Machine Learning, Computational Intelligence (Neural Networks, Fuzzy and Hybrid Systems, Intelligent Optimization and Search), Knowledge-based Systems);
- Computer Science Methods for Modeling;
- Info-Communication Technologies for Data Analysis (Data Mining, Decision Support, Signal and Image Processing) and Applications for Engineering, Medicine and Education.

There CMIS-2022 workshop countries of PC members and authors of submitted papers are: Belgium, Estonia, Germany, India, Israel, Kazakhstan, Netherlands, Poland, Portugal, Slovakia, Spain, Ukraine, United Kingdom, and United States of America. The number of countries of CMIS-2022 authors and PC members is 14 (instead of 21 in 2021, and 12 in 2020).

The language of CMIS-2022 Workshop is English. The workshop took the form of oral presentations of peer-reviewed regular papers. The video of presentations is available at <https://www.facebook.com/groups/cmis.workshop/>.

The CMIS-2022 Organizing Committee have received 53 paper submissions (instead of 122 submissions in 2021, 177 submissions in 2020, and 130 submissions in 2019), out of which 25 were accepted for presentation as a regular papers (instead of 44 in 2021, 83 in 2020, and 81 in 2019) in the result of reviewing process, where the editor, program committee members, external and peer reviewers sought to ensure a high scientific level, as well as a high-quality presentation of the selected papers.

The paper acceptance ratio in 2022 is 47% (instead of 39% in 2021, 47% in 2020, and 62% in 2019). These papers were published in this volume of CMIS-2022 proceedings.

The workshop would not have been possible without the support of many people. I would like to thank the Workshop Program Committee Members, organization staff, and external reviewers for their excellent and tireless work. I sincerely wish that all attendees benefited scientifically from the workshop and wish them every success in their research. It is the humble wish of the workshop organizers that the professional dialogue among the researchers, scientists, and engineers continues beyond the event and that the friendships and collaborations forged will linger and prosper for many years to come.

May, 2022

Sergey Subbotin, Dr. Sc., Prof.,
CMIS-2022 PC Chair and Proceedings Editor
Head of the Department of Software Tools,
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