4th Workshop for Young Scientists in Computer Science & Software Engineering

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Abstract

This is an introductory text to a collection of selected papers from the 4th Workshop for Young Scientists in Computer Science & Software Engineering (CS&SE@SW 2021), which was held in Kryvyi Rih, Ukraine, on the December 18, 2021. It consists of short summaries of selected papers and some observations about the event and its future.

Keywords

computer science, software engineering, young scientists

1. CS&SE@SW 2021: At a glance

Workshop for Young Scientists in Computer Science & Software Engineering (CS&SE@SW) is a peer-reviewed workshop focusing on research advances, applications of information technologies.

CS&SE@SW topics of interest since 2018 [1, 2, 3, 4] are:

- Computer Science (CS):
  - Theoretical computer science
    - Data structures and algorithms [5]
  - Computer systems
    - Computer performance analysis [6]

CS&SE@SW 2021: 4th Workshop for Young Scientists in Computer Science & Software Engineering, December 18, 2021, Kryvyi Rih, Ukraine

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        * Databases [7]
    - Computer applications
        * Computer graphics and visualization [8]
        * Human-computer interaction [8, 7, 9, 10]
        * Scientific computing [11, 5, 12]
        * Artificial intelligence [8, 13, 7, 12, 10, 14]
- Software Engineering (SE):
    - Software requirements [15]
    - Software design [7, 16, 17, 18, 19]
    - Software construction [20, 11, 7, 16, 17, 19]
    - Software configuration management [11]
    - Software development process [7, 17, 19]
    - Software engineering professional practice [21, 22]
    - Software engineering economics
    - Computing foundations [5]
    - Mathematical foundations [12]
    - Engineering foundations [12]

This volume represents the proceedings of the 4th Workshop for Young Scientists in Computer Science & Software Engineering (CS&SE@SW 2021), held in Kryvyi Rih, Ukraine, on December 18, 2020. It comprises 2 keynotes and 15 contributed papers that were carefully peer-reviewed and selected from 22 submissions. Each submission was reviewed by at least 3, and on the average 3.14, program committee members. The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research.

2. CS&SE@SW 2021 Program Committee

Dr. **Stuart Charters**, Senior Lecturer in Applied Computing, Lincoln University, Canterbury, New Zealand.

Stuart Charters, received a Bachelor of Science with Honours (Computer Science) and a Doctor of Philosophy from Durham University. Since 2006, he has worked at Lincoln University, New Zealand where he is currently Programme Director for the Master of Applied Computing. His research interests include evidence-based software engineering, visualization and the application of technology in agroecological contexts.

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Prof. Pavlo Hryhoruk received a Doctor of Economic Sciences degree from the Khmelnytskyi National University in 2013. Since 1997, he has been working in economic and mathematical modeling at the Khmelnytskyi National University, where he is currently Head of the Department of Automated Systems and Modeling in Economics. He is Editor-in-Chief of "Herald of Khmelnytskyi National University. Economic Sciences", Deputy Editor-in-Chief of the scientific journal "Modeling the Development of the Economic Systems". He has published more than 100 scientific manuscripts in domestic and international journals and book series, two monographs, twelve chapters in collective monographs. Fields of studies are related to decision-making, multidimensional modeling of socio-economic systems, comprehensive assessment of economic phenomena latent characteristics, financial security, sustainable development, information technologies in education.

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Dr. **Oleksii Ignatenko**, deputy director of research, Institute of Software Systems NAS Ukraine, Kyiv, Ukraine.

Oleksii Ignatenko, born in 1979, received a Candidate of Physical and Mathematical Sciences from V. M. Glushkov Institute of Cybernetics NAS Ukraine, in 2007 and a Doctor of Physical and Mathematical Sciences from Institute of Software Systems NAS Ukraine in 2019. Since 2002, he has been working in the field of game theory and its applications in computer science, agent-based modeling, reinforcement learning. He is an associate professor at the Institute of Applied System Analysis of Igor Sikorsky Kyiv Polytechnic Institute (from 2006), Kyiv-Mohyla Academy (from 2019) and Kyiv Academic University (from 2019). He is a Vice Editor of Problem of Programming Journal.

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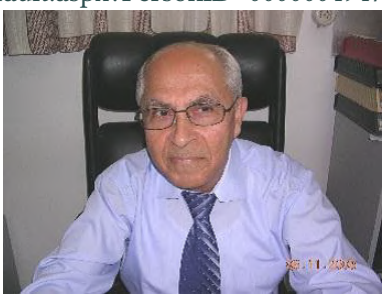

Dr. **Arnold Kiv**, Ben-Gurion University of the Negev, Israel.

Arnold Kiv received the D. Sc. (Dr. Hab.) degree in solid state physics from Tartu Institute of Physics, Tartu, Estonia, in 1978. From 1964 to 1982, he was a Senior Researcher and a Head of the Laboratory of Radiation Effects, Institute

of Nuclear Physics, Academy of Sciences, Tashkent, Uzbekistan. From 1983 to 1998, he was a Head of the Department of Theoretical Physics, South-Ukrainian National Pedagogical University, Odessa, Ukraine. In 1997, he was an Invited Professor, Western Ontario University, Canada. From 1999 to the present, he is a Professor-Researcher in the Department of Materials Engineering, Ben-Gurion University of the Negev, Israel. In 1996 and 2011 he was co-Director of NATO Advanced research Workshops and an Editor of two NATO Series books. He has about 200 publications, three monographs and three Invention Certificates in the field of radiation effects in solid state electronics. His research interests include mechanisms of formation of radiation defects in solids, interaction of fast particles with materials, radiation methods in microelectronics, including computer simulation, analytical calculations and experimental studies.

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Oleksandr Kolgatin, born in 1966, received a Candidate of Technical Sciences degree (Dr. phil.) from the Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine, in 1995, the field of scientific interests was computational modeling of the heat and mass transfer processes. Since 1990, he worked in the field of teaching informatics and using information technologies in education and received a Doctor of Pedagogical Sciences degree (Dr. habil.) from the Institute of Information technologies and Learning Tools of the National Academy of Pedagogical Sciences of Ukraine, in 2011. His research interests include computational modeling, pedagogical diagnostics, information systems and technologies in education. He has published a number of papers in international journals and volumes in book series, is a member of editorial boards of Journal of Information Technologies in Education and associate editor of Information Technologies and Learning Tools.

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Andrey Kupin was born in Slovianoserbsk, Luhansk region, Ukraine, in 1972. He received the engineering degree in robotic systems and complexes from East-Ukrainian State University, in 1994 and the Ph.D. degree in automation from Kryvyi Rih Technical University, in 2001. From 2006 to 2007, he worked as an Associated Professor of the Department of Informatics, Automation and Control Systems. In 2010 he

became a doctor of science in automation, professor (2013). Dean of the Faculty of Information Technology (2011–2015). From 2007 he is the Head of the Department of Computer Systems and Networks. He is the author more than 190 articles and 8 patents. Professor Kupin as a scientific adviser has prepared 4 PhD and 1 DrSc. His research interests include artificial intelligence, information and integrated automation of technological processes.

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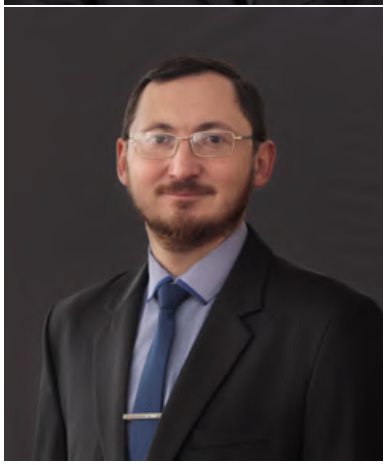

Dr. **Viacheslav Osadchyi**, Professor of Department of Computer Science and Cybernetics, Bogdan Khmelnitsky Melitopol State Pedagogical University, Melitopol, Ukraine.

Viacheslav Osadchyi, born in 1975, received a Candidate of Pedagogical Sciences (PhD in Education) from the Vinnytsia State Pedagogical University named after Mykhailo Kotsiubynsky, Ukraine, in 2006, and a Doctor of Pedagogical Sciences from the Vinnytsia State Pedagogical University

named after Mykhailo Kotsiubynsky, Ukraine, in 2013. Since 1999, he has been working in the field of information technology and vocational education at the Bogdan Khmelnitsky Melitopol state pedagogical university. Now – Head of the Department of Computer Science. Her research interests include: computer science, information networks, ICT, programming, software development, information systems, data science. He has published a number of papers in international journals. He is a member of editorial boards of "Ukrainian Journal of Educational Studies and Information Technology" (Ukraine), "Computing Conference (formerly called Science and Information (SAI) Conference)" (UK), Intelligent Systems Conference (IntelliSys) (The Netherlands), "International Conference on Higher Education Advances" (Spain), "Transactions of Kremenchuk Mykhailo Ostrohradskyi National University" (Ukraine), "Information Technologies and Learning Tools" (Ukraine), "Scientific papers of Berdyansk State Pedagogical University Series: Pedagogical sciences" (Ukraine).

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Marco Roveri received a Ph.D. degree in Computer Science from the University of Milano, Italy in 2002. He is an Associate Professor in the Information Engineering and Computer Science Department of the University of Trento, Italy. He was Senior Researcher in the Embedded Systems Unit of Fondazione Bruno Kessler in Trento, and before a researcher in the Automated Reasoning Division of the Istituto Trentino di Cultura also in Trento. His research interests include automated formal verification of hardware and software systems, formal requirements validation of embedded systems, model based predictive maintenance, and automated model based planning, and application of such techniques in industrial settings.

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Andrii Striuk, born in 1979. In 2000 he graduated from the Kryvyi Rih Technical University with a degree in Automated Systems Software. In 2001, he received a master's degree in computer science. Has been working at the Department of Modeling and Software of Kryvyi Rih National University since 2000. Combines educational activities with practical, developing and implementing educational software products. In 2011 he defended his Ph.D. thesis. From 2014 to 2017 he is studying at the doctoral program in Institute of Information Technologies and Learning Tools of the NAES of Ukraine (Kyiv, Ukraine). In 2017, he was awarded the Prize of the President of Ukraine for young scientists. Heads the Simulation and Software Engineering department of Kryvyi Rih National University since 2018. Field of scientific interest: professional training

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3. CS&SE@SW 2021 keynotes

This year a 3 keynote speakers were selected by CS&SE@SW 2021 program committee (figure 1):

(1) Andrii I. Kostromytskyi "How to become a professional DevOps" (abstract only, [21], figure 2);
(2) Bohdan V. Hrebeniuk "Effective participation in programming contests" (abstract only, [22], figure 3);
(3) Andrii M. Striuk "Software requirements engineering training: problematic questions" (full paper, [15], figure 4).

4. CS&SE@SW 2021 papers overview

4.1. Software engineering

The article "Software requirements engineering training: problematic questions" [15] by Andrii M. Striuk (figure 4), Serhiy O. Semerikov, Hanna M. Shalatska and Vladyslav P. Holiver

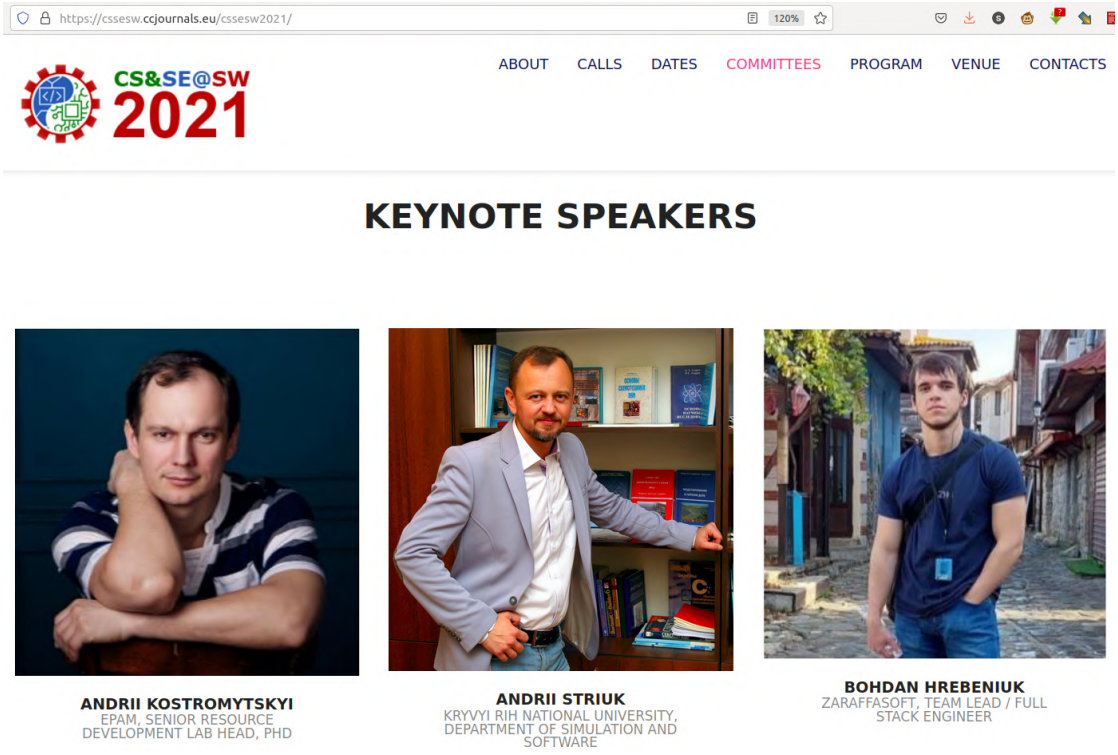

Figure 1: CS&SE@SW 2021 keynote speakers.

discusses the key problems of training Requirement Engineering and the following ways to overcome the contradiction between the crucial role of Requirement Engineering in industrial software development and insufficient motivation to master it in the process of Software Engineering specialists professional training were identified based on a systematic research analysis on the formation of the ability of future Software Engineering specialists to identify, classify and formulate software requirements: a) use of activity and constructivist approaches, game teaching methods in the process of modeling requirements; b) active involvement of stakeholders in identifying, formulating and verifying requirements at the beginning of the project and evaluating its results at the end; c) application of mobile technologies for training of geographically distributed work with requirements; d) implementation of interdisciplinary cross-cutting projects on Software Engineering; e) involvement of students in real projects; f) stimulating the creation of interdisciplinary and age-old student project teams.

This article highlights further research by the authors, begun in [23, 24, 25, 26, 27, 28, 29].

Personal finances are the own capital of an individual or family, which he manages independently. Personal finance management includes the ability to manage them, which requires separate training. The purpose of the article “Development of a simulator to determine personal financial strategies using machine learning” [20] by Dmytro S. Antoniuk, Tetiana A. Vakaliuk, Vladyslav V. Didkivskyi and Oleksandr Yu. Vizghalov (figure 5) is to develop the mechanics of a personal finance simulator and build a system for determining personal financial strategies

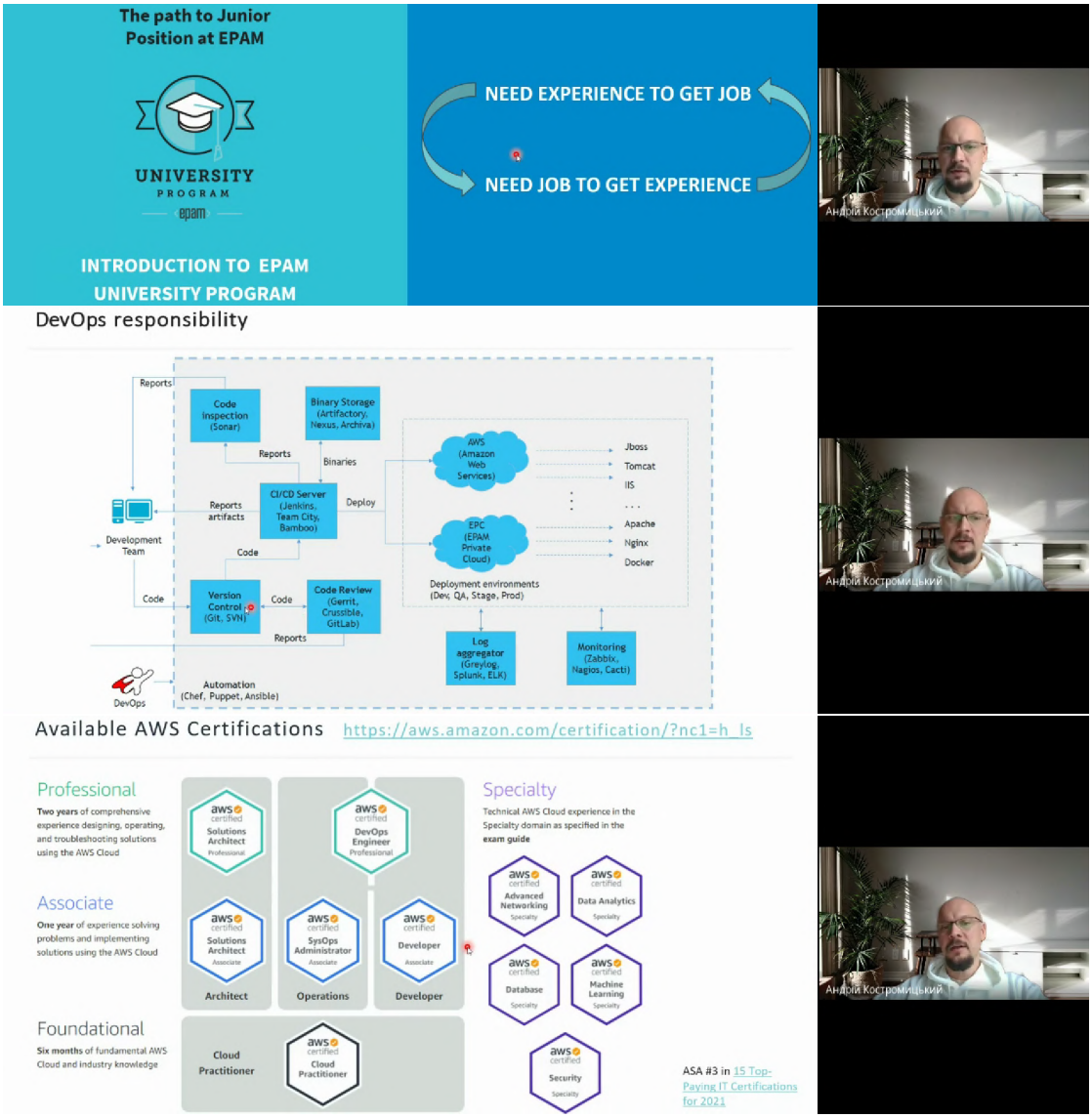

Figure 2: Andrii I. Kostromytskyi “How to become a professional DevOps” [21].

using machine learning. The development of a personal finance management simulator will allow in the future using it to teach the elements of managing such finances, even at school age. The developed software package consists of two parts: a personal finance management simulator and a system for determining financial strategies, which uses reinforced learning opportunities. The direction of future research is the integration of the recommendation system into the web application of the simulator. In addition, to improve the system and give flexibility in recommendations that could be adjusted to the current financial condition of the participant, it is necessary to pay attention to the use of “policy-based” methods of training with reinforcement, which are widely used in autopilot training systems for cars. Just as an autopilot cannot

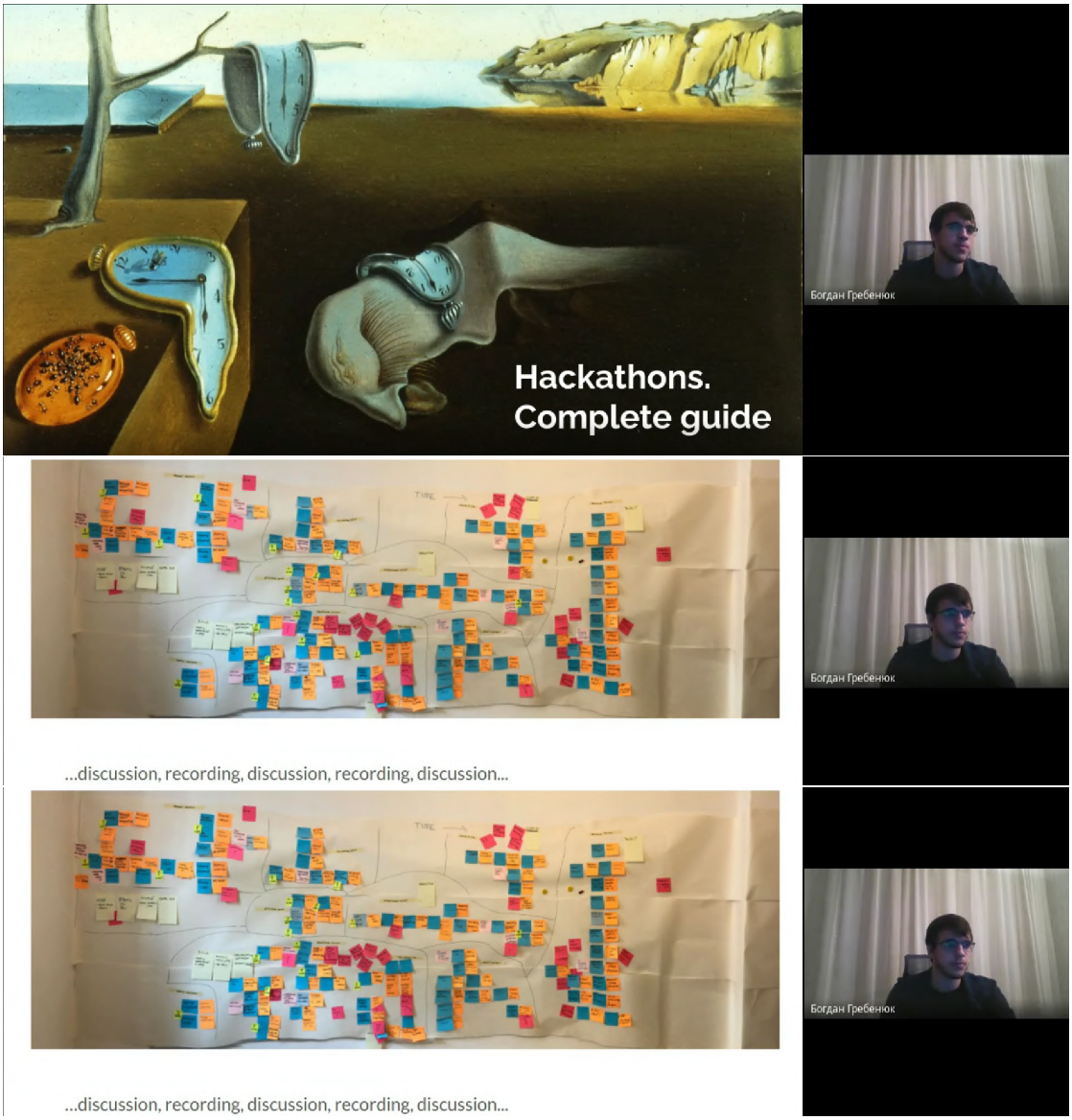

Figure 3: Bohdan V. Hrebeniuk “Effective participation in programming contests” [22].

predict what may happen on the road in a second, can a person predict neither unexpected expenses nor profits (which is rare, but can happen).

This article highlights further research by the authors, begun in [30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49].

The article “Development of a machine vision program to determine the completeness of wrapping plants in the soil” [11] by Oleksandr V. Kanivets (figure 6), Irina M. Kanivets, Tetyana M. Gorda and Oleksii A. Burlaka analyzes the process of natural restoration of the main component of the soil – humus, as a result of which the dependence of the thickness of the humus layer on

Figure 4: Presentation of paper [15].

the number of plants embedded in the soil was revealed. The technological process of surface tillage requires constant monitoring of the completeness of plant burying. The article analyzes the literature, which showed that machine vision systems are widely used in agriculture, for example, when detecting weeds for spot treatment with herbicides, analyzing citrus forms and diseases, automated counting of roundworms of cut trees, etc. A machine vision system is proposed as a control tool for detecting weeds on the soil surface. The authors proposed their own approach to control the completeness of burying pruned weeds in the soil using machine vision systems. The work of our own program for detecting weeds on the soil surface is described in detail and step by step. The program's operability was checked on some plant models and its effectiveness of reliable operation was confirmed. Experimental studies were conducted in the laboratory. Based on the results of research in the computer program developed by the authors, the following results were obtained: photos of the soil surface were analyzed; contours of plant models were identified; plant areas and their percentage in relation to the image area were determined, and a message was received on the screen about the presence of weeds on the surface in accordance with agrotechnical standards.

This article highlights further research by the authors, begun in [50, 51].

The article "Development of CRM system with a mobile application for a school" [16] by Nataliia I. Cheboksarova (figure 7), Tetiana A. Vakaliuk and Iurii M. Iefremov substantiates the need to develop a CRM system with a mobile application for a school. The existence of their educational environment, which will provide interaction between pupil and teacher in a school, is a topical issue today. Relationship management can be implemented in the form of a CRM system. For a deeper understanding of the research problem, certain analogs are considered, their advantages and disadvantages are given. The work aims to design and develop a CRM system with a mobile, cross-platform, application for a school. As a result, the architecture of the software package was built, the choice of tools was substantiated, the use and structure of the system were determined, the object-oriented structure of the system was designed, the data storage structure was developed, the system operation algorithms were designed and implemented, the system installation and administration procedure the procedure for working with the software package.

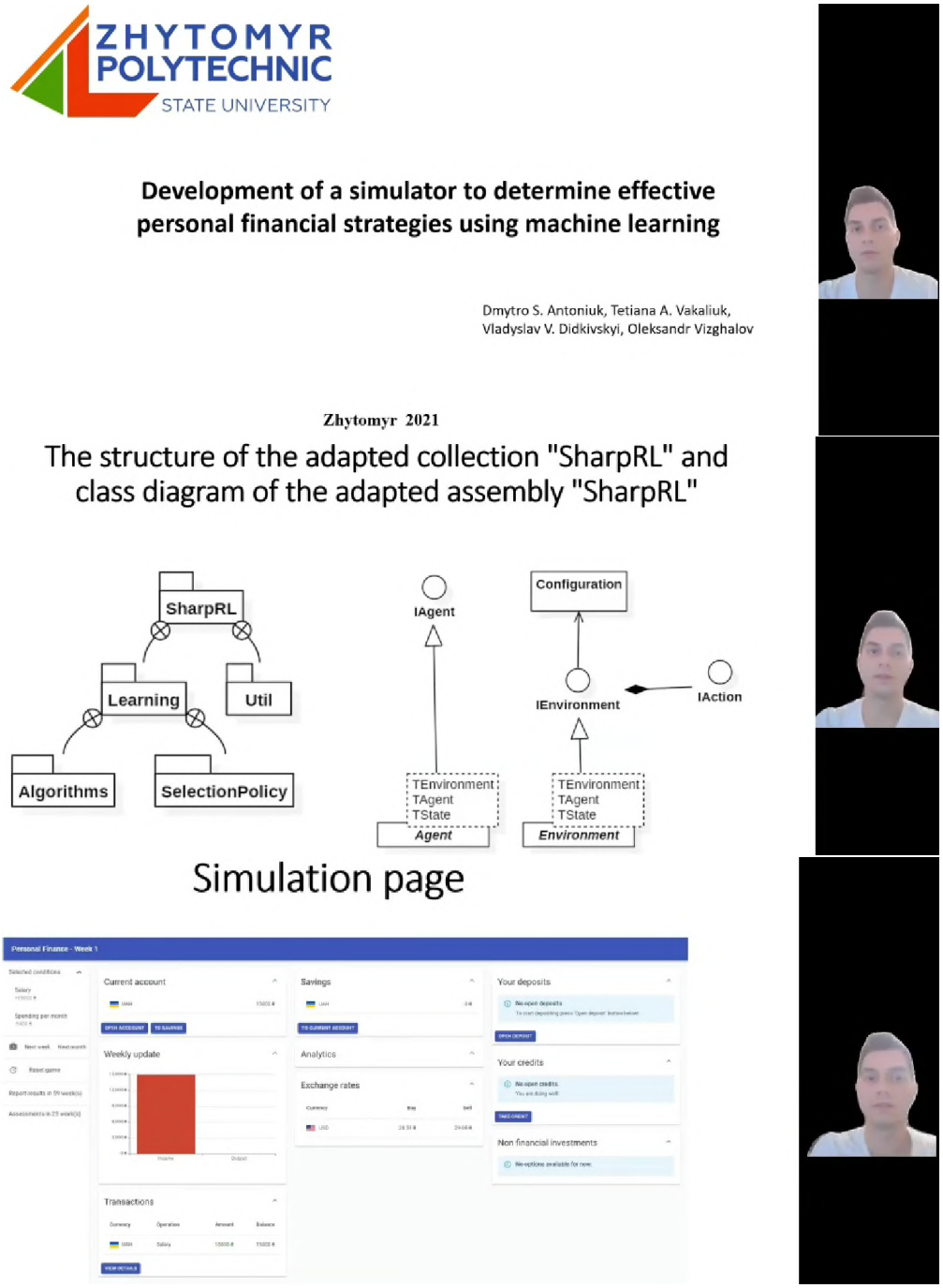

Figure 5: Presentation of paper [20].

The rapid growth of modern information technologies influences all aspects of human life. Companies all over the world are adopting new approaches to solve business problems, such

Figure 6: Presentation of paper [11].

as diverse automation, by using information technologies. Automation substitutes routine human work and noticeably increases efficiency. The article "An approach for processing and document flow automation for Microsoft Word and LibreOffice Writer file formats" [17] by Pavlo V. Zahorodko (figure 8) and Pavlo V. Merzlykin examines different approaches to document automation. Basic concepts of document processing using XML and existing solutions have been reviewed and a library based on LibreOffice UNO API has been designed and implemented.

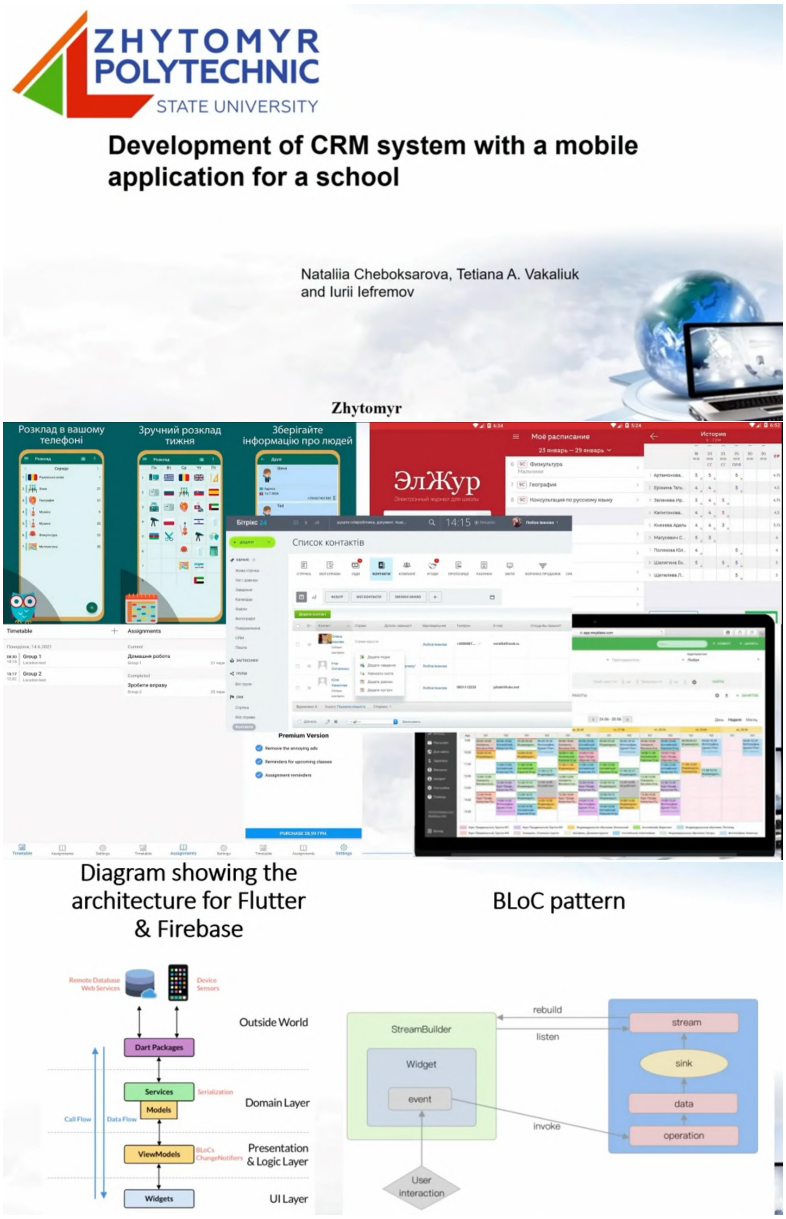

Figure 7: Presentation of paper [16].

The library contains different helpers, wrappers, and processing tools to create an additional layer of abstraction. Moreover, the library is aimed at simplifying processing, working, and converting documents, which might considerably optimize a process of creating document reports generators.

This article highlights further research by the authors, begun in [52, 53, 54, 55, 56, 57, 58].

The role of progressive web applications in students' educational activities is researched in the article "Design a progressive web application to support student learning" [18] by Svitlana

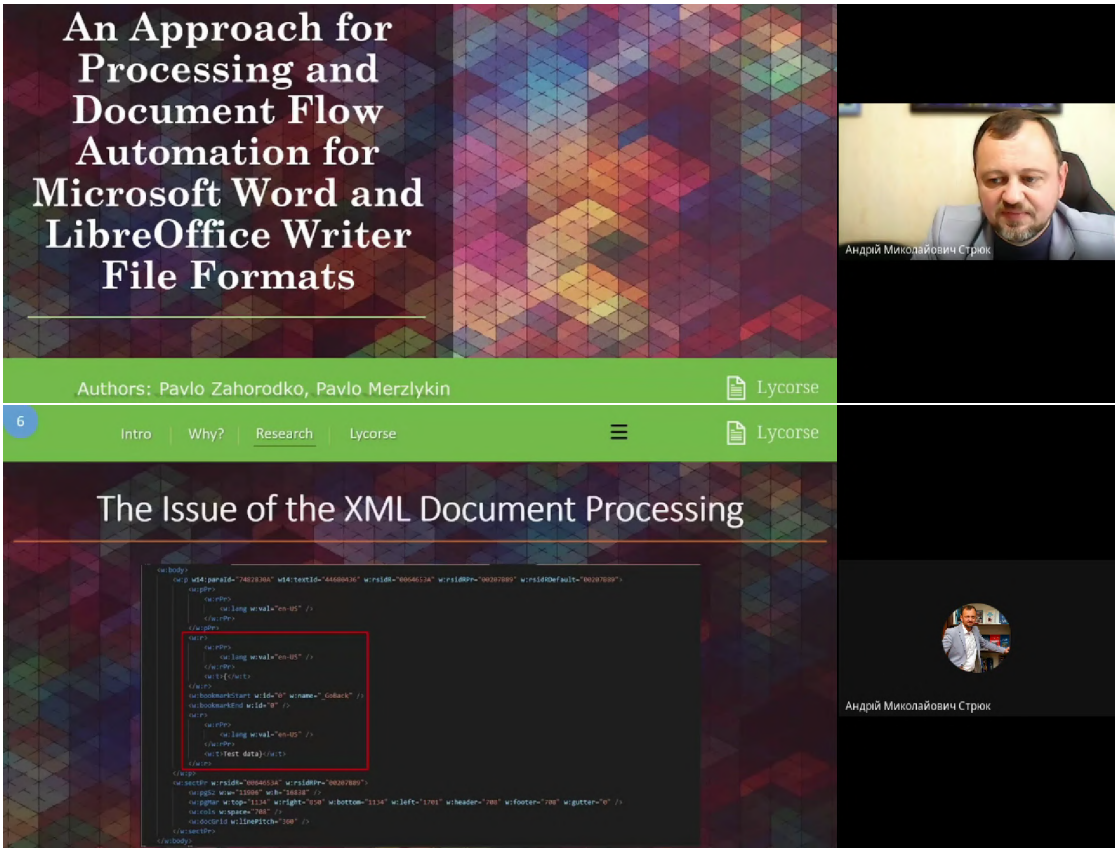

Figure 8: Presentation of paper [17].

O. Leshchuk, Yurii S. Ramskyi (figure 9), Anastasia V. Kotyk and Serhiy V. Kutsiy. Authors compare them with applied and hybrid programs; determine the features of PWA technology as well as analyze the architecture of progressive web applications. The study aim is to develop and implement the progressive web application that is an information portal of the Faculty of Physics and Mathematics Ternopil Volodymyr Hnatiuk national pedagogical university using PWA technology. To achieve this goal, the following required resources for the' training organization of student's activities have been selected. They are the schedule of the educational process, lessons schedule, schedule of modular and final controls, information on practice, schedule of final exams, regulatory and methodological software. On the first stages of work a website template was created in addition to information gathering. The next stages of practical implementation were aimed at the development of logic and implementation of PWA technology, namely defining the interface, adding a worker, creating auxiliary functions. The final stage of the study is the project deployment. The results obtained by the authors can be used in the process of higher specialists training in educational institutions. The web application itself is practical for organizing students' educational activities.

This article highlights further research by the authors, begun in [59, 60].

E-petition is a relatively new tool for expressing community demands and influencing on the

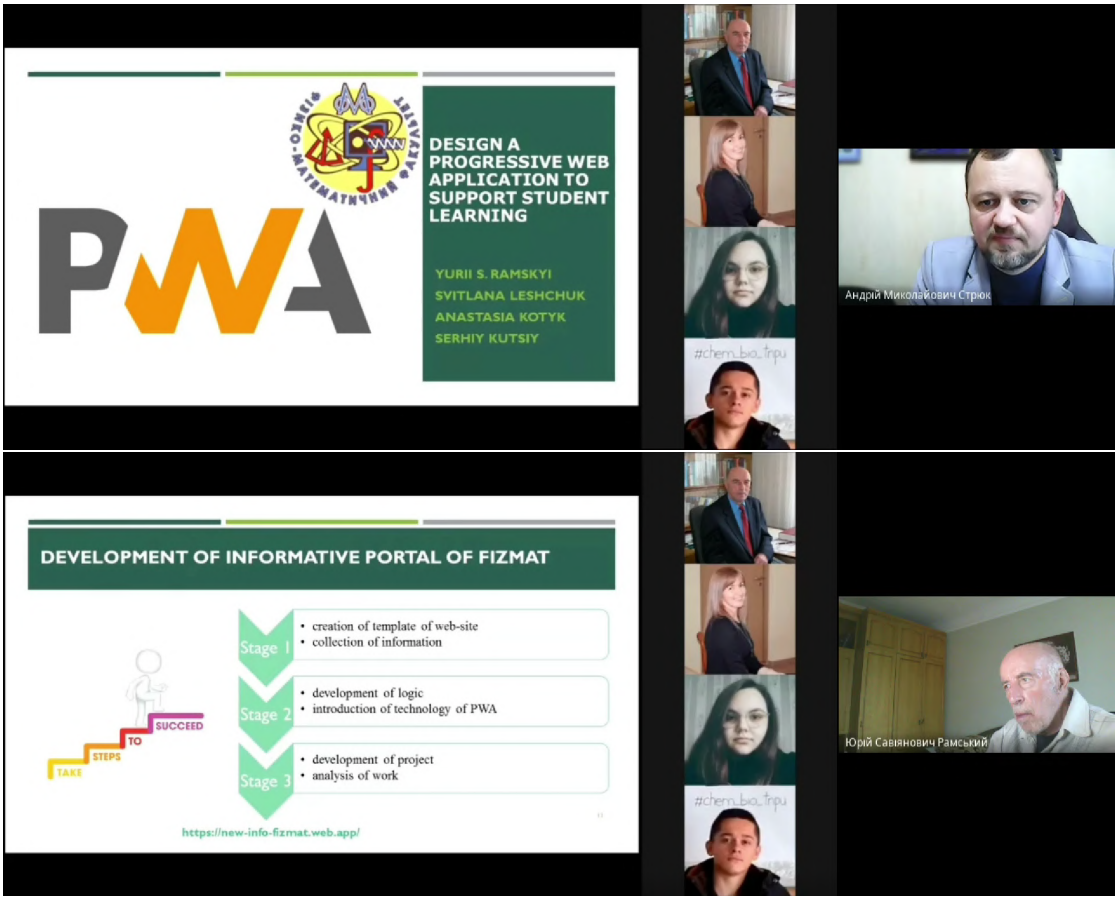

Figure 9: Presentation of paper [18].

legislative process. An issue of voting falsifications detection is rarely considered in e-petition analysis reports. Within research "Designing a software for digital forensic investigations of e-petitions voting falsifications" [19] by Ivan I. Kovalenko (figure 10) and Pavlo V. Merzlykin, an illegal petition falsification service has been examined and some methods of voting fabrication detection have been suggested and implemented in mobile app. To illustrate the discussed techniques, some suspicious activities regarding two popular petitions to the president of Ukraine were detected.

4.2. Theoretical computer science

Mathematical models building is widely used in different branches of human activity to describe statistical data obtained during observation of various phenomena. The main tool for this problem solution is approximation theory, especially ordinary least squares method. Basic goal during approximation is minimizing deviation between observed and estimated data. Analysis showed that providing given accuracy is possible based on usage of segmented regression models. Such models contain one or more switching points for segments connection. The

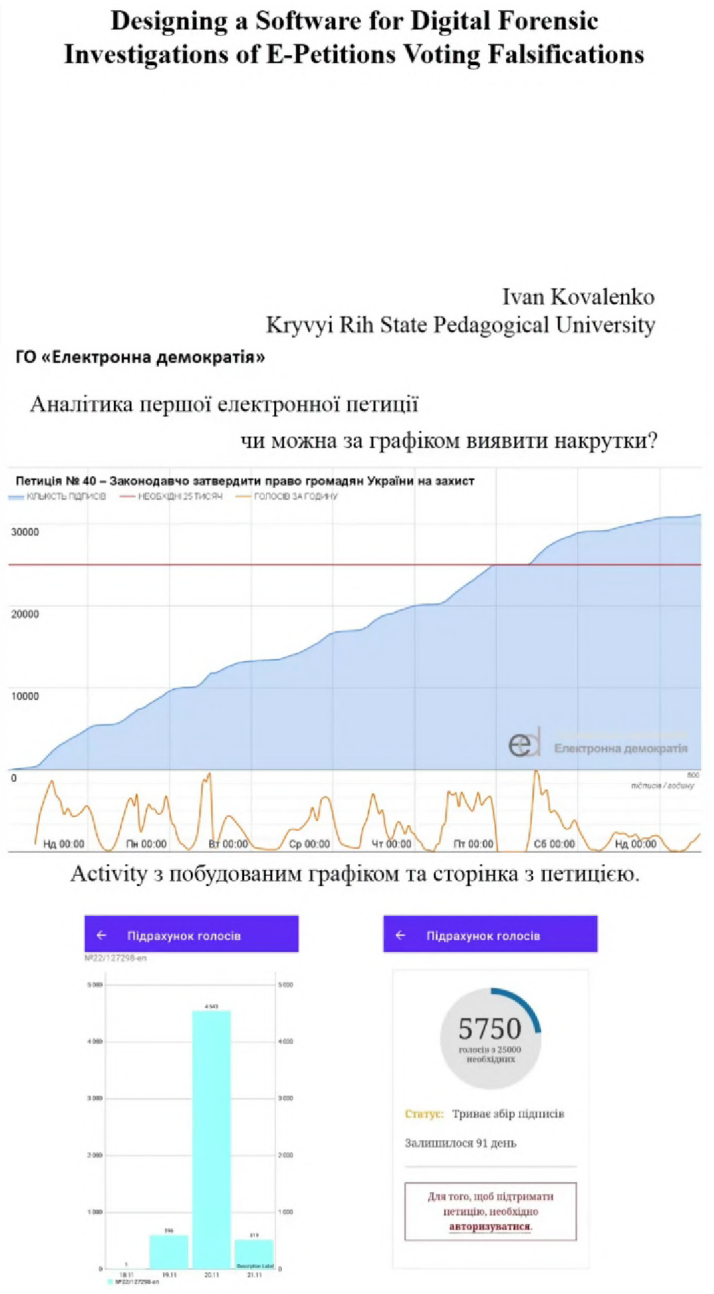

Figure 10: Presentation of paper [19].

article “New approach to switching points optimization for segmented regression during mathematical model building” [5] by Valeriyi M. Kuzmin, Maksym Yu. Zaliskyi (figure 11), Roman S. Odarchenko and Yuliia V. Petrova deals with a problem of calculation of optimal values of switching point abscissa for segmented regression. Analytical expression for segmented

regression was obtained using the Heaviside function. Switching point's determination is based on the usage of multidimensional optimization paraboloid. Paper presents the methodology for optimal segmented regression building. Simulation results and example of data processing proved increasing the accuracy of approximation in case of using the proposed methodology.

Figure 11: Presentation of paper [5].

4.3. Computer systems

The article "Available parking places recognition system" [7] by Vitalii L. Levkivskyi (figure 12), Dmytro K. Marchuk, Nadiia M. Lobanchykova, Ihor A. Pilkevych and Dmytro I. Salamatov describes algorithms and methods of working of the available parking places recognition system by analyzing the flow of video data, coming from the city cameras. Search an available parking place is usually a significant problem in modern cities, which requires finding new information technologies, approaches to solve it. Therefore, the purpose of this work is to analyze existing solutions and finding new information technologies for the task of optimizing the parking process. In addition, the software implementation of the proposed algorithms and methods has been implemented. The system was developed with Python and PHP programming languages. With Python an algorithm for recognizing free spaces for car parking and a chatbot for Telegram were implemented. PHP was used for the developing of the content management system with MVC (Model-View-Controller) architectural pattern. MySQL was chosen as the database management system. Communication between the chatbot and the script for recognition is carried out using memory-resident NoSQL DBMS Redis. The implemented system allows drivers to search available parking places in the selected parking lot with a minimum of time, providing information via a Telegram chatbot. The system can be deployed on Apache2 webserver and Linux OS.

This article highlights further research by the authors, begun in [61, 62, 63, 64, 65].

Causes and solutions of the problem of free space lack on the system partition during exploitation of Windows (Vista/7/8/8.1/10) operating system are analyzed in the article "Research methods and tools for cleaning the system partition of Windows operating systems" [6] by Andrii P. Stupin (figure 13), Vitalii V. Bulatetskyi, Lesia V. Bulatetska, Tetiana O. Hryshanovych and Yuliia S. Pavlenko. Main objects of the file structure, system paths to them, their purpose and role in system partition space usage have been prospected. Some operating system settings that allow to manage relatively large system files and folders and adjust the amount of free space have also been explored. In the course of the research, a set of third-party software was used as an auxiliary tool to compare the cleaning efficiency of individual objects of the system partition and to form own cleaning methods. Commands sets for correct cleaning of such objects are offered. They can be used for writing batch files and scripts, which allows automating the system partition optimizing process in the future.

This article highlights further research by the authors, begun in [66].

4.4. Computer applications

The usage of serious games with AI and immersive technologies in education is considered in the article "Game based learning with artificial intelligence and immersive technologies: an overview" [8] by Yulia Yu. Dyulicheva and Anastasia O. Glazieva (figure 14). Authors discussed the development of serious educational games with adaptability and personalization based on recognition of the images, human emotions, speech, and intelligent agents usage for the simulation of "being there" effect of a human opponent, and control of the complexity of game levels and game contents. Authors investigated some tools for teachers and students to allow the creation of the educational games based on AI and immersive technologies without

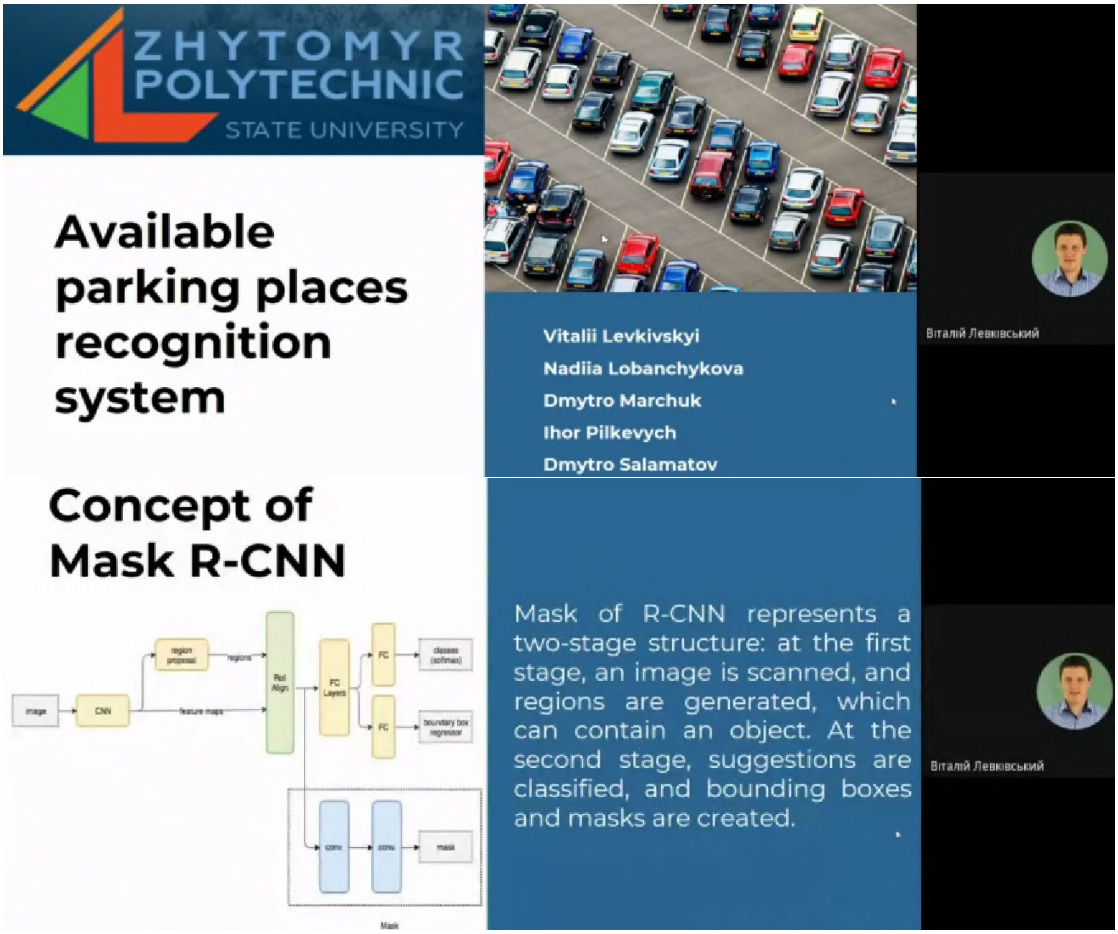

Figure 12: Presentation of paper [7].

programming skills existence: Aurora Neverwinter Nights toolset, eCraft2Learn tool with visual programming on Snap!, Scratch with AI abilities, Metaverse Studio for AR applications development with computer vision models using Google AI, CoSpaces Edu and EV Toolbox constructors for immersive apps.

This article highlights further research by the authors, begun in [67, 68].

Due to the similarity of the computational and probabilistic nature of quantum computing and machine learning, the idea arose to optimize the learning process using quantum methods. There are both fundamentally new algorithms, such as HHL, and quantum-improved ones: QPCA, QSVM. In the article "Classification problem solving using quantum machine learning mechanisms" [13], Alina O. Savchuk (figure 15) and Nonna N. Shapovalova are look at the QSVM algorithm step by step, starting from the basics described in section 2 and gradually delving into the composition of the algorithm. Thus, after the basics, authors considered the quantum phase estimation, which is part of the HHL algorithm, and then the QSVM algorithm, the component of which is the HHL. Authors also considered the QPCA algorithm, which

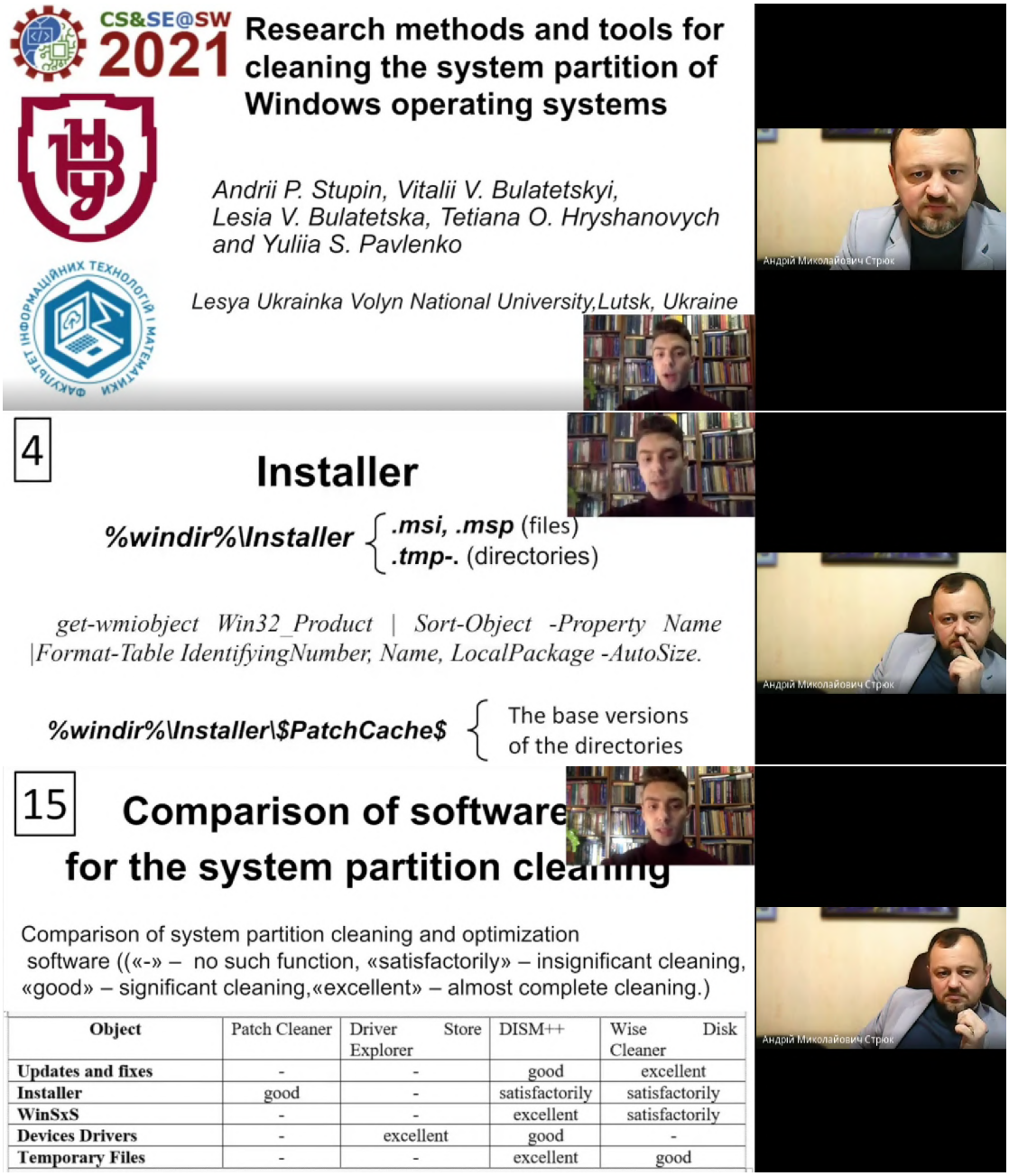

Figure 13: Presentation of paper [6].

can be applied before the QSVM algorithm to reduce the dimension of the data sample. In this way, authors explore the fundamental difference between classical algorithms and their quantum counterparts. Authors also implement the QSVM method in practice and compare the obtained practical results with theory. As a result, they obtained high quality of accuracy (100 %)

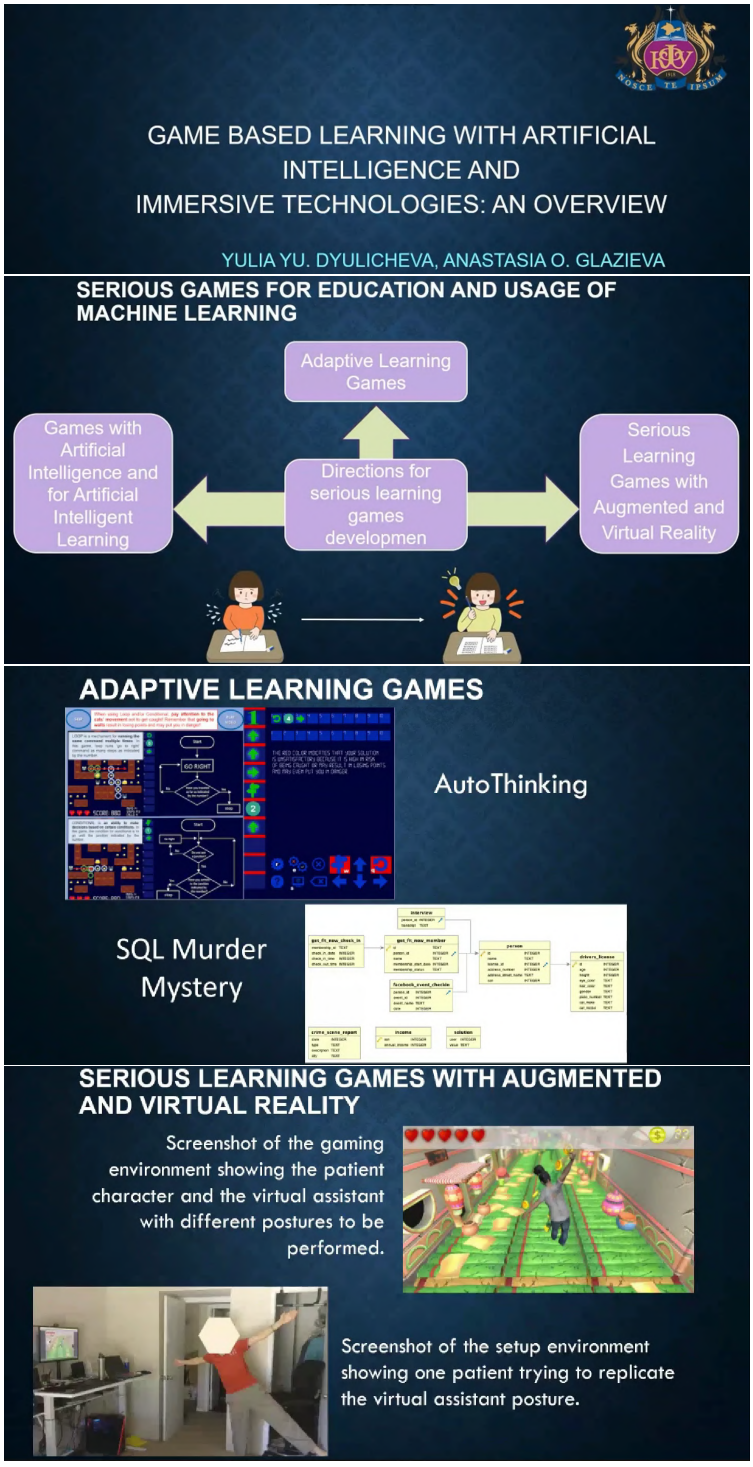

Figure 14: Presentation of paper [8].

compared to the classical SVM (83 %) on a data sample of dimension 72. However, authors found out that the learning time on a quantum device is far from ideal (it can reach 5 min for a sample of this size). The study aims to theoretically argue or disprove the hypothesis about the efficiency of quantum computing for machine learning algorithms. The object of research is the programming of quantum computers. The research subject is the study of quantum computing mechanisms for the implementation of machine learning problems. The research result is a software module that allows evaluating the efficiency of the classification task on a quantum computer. It also can be used to compare the results obtained from classical and quantum devices. Research methods: theoretical analysis of the foundations of quantum computing: principles of superposition and entanglement, linear algebra, probability theory over complex numbers; building a model of one qubit and multi-qubit system; research of quantum machine learning algorithms' work principles and their complexity; empirical comparison of quantum machine learning methods with their classical counterparts.

This article highlights further research by the authors, begun in [69, 70].

A system and method of automatic collection of objects in a room focused on the minimum energy consumption is proposed in the article "System and method of automatic collection of objects in the room" [9] by Mariia Yu. Tiahunova (figure 16), Halyna H. Kyrychek, Tetiana O. Bohatyrova and Daryna D. Moshynets. This result is achieved by the implementation of an improved method of automatic collection of items in the room and mathematical method for calculating the desired motion trajectory; development and implementation of algorithms that implement the proposed method; software and hardware implementation of the system for automatic collection of items with minimal energy consumption, including the small number of system components and an improved movement trajectory. The system's main component is the Arduino Uno, which acts as a controller. The developed software makes it possible to evaluate the implemented method's effectiveness in a real-life system. An application example of the proposed method is given.

This article highlights further research by the authors, begun in [71].

The article "Methodology for control of helicopters aircraft engines technical state in flight modes using neural networks" [12] by Serhii I. Vladov (figure 17), Yurii M. Shmelov and Ruslan P. Yakovliev is devoted to the development of a methodology for control of helicopters aircraft engines technical state using recurrent neural networks, which, unlike other types of neural networks, have a more optimal method for training a neural network, and also after training allows you to get a lower percentage of errors in comparison with a convolutional neural network and multilayer perceptron. A mathematical description of the methodology for control of helicopters aircraft engines technical state in flight mode with the use of neural networks, which is based on the numerical solution of a discrete optimal control problem, has been implemented. The quality of the trained neural network is assessed, including the calculation of the testing error, which is no more than 1.2 % of the deviation from the a priori correct result on the vectors of the test set of sets. With an allowable value of 2 %, this allows to speak about the efficiency of the method.

The perspectives of application of machine learning, especially, decision trees, random forest and deep learning for educational data mining problem solving, and learning analytics tools development are considered in the article "Learning analytics of MOOCs based on natural language processing" [10] by Yulia Yu. Dyulicheva and Elizaveta A. Bilashova (figure 18) .

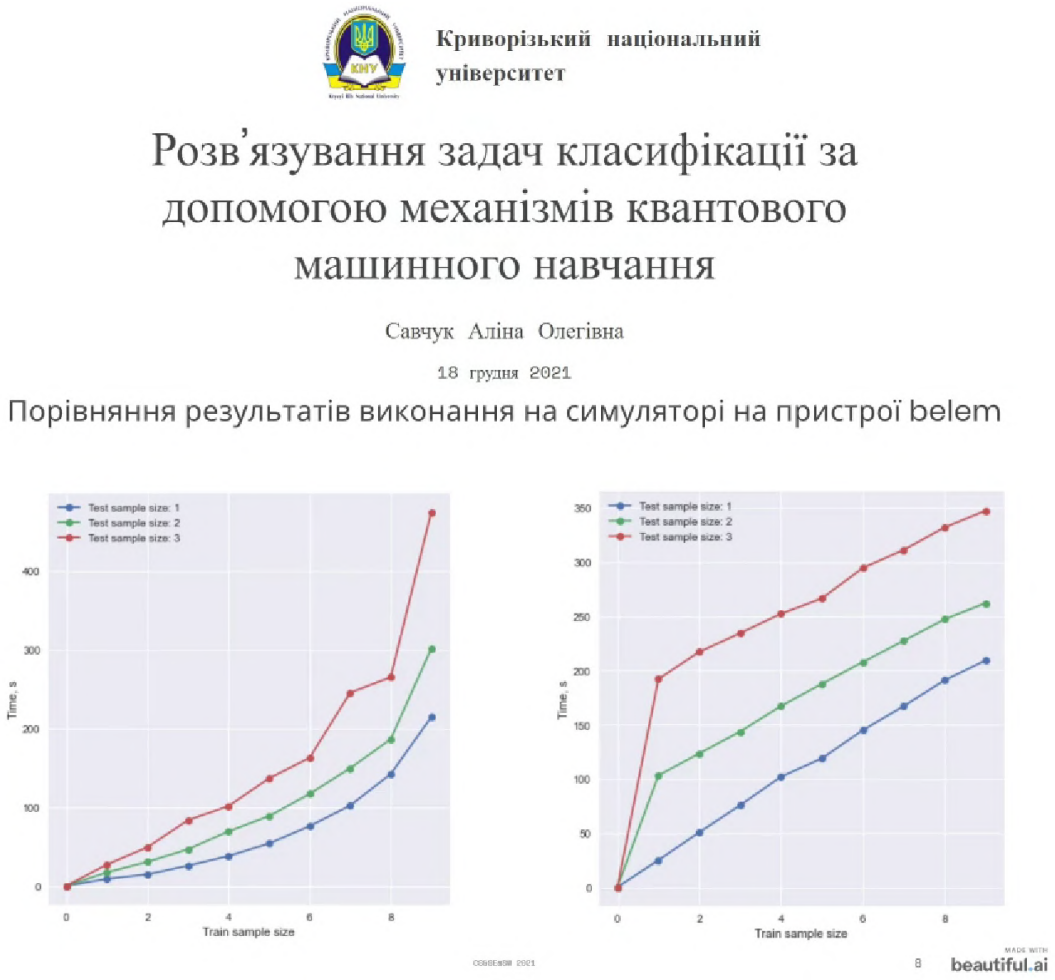

Figure 15: Presentation of paper [13].

The abilities of sentiment analysis with BERT deep model, clustering based on kMeans with the different approaches to the text vectorization are investigated for the development of learning analytics tools on the example of the learning analytics of some programming MOOCs from Udemy. Authors analyze 300 titles of MOOCs and proposed their clustering for better understanding the directions of learning and skills, and 1150 sentences that contain the word "teacher" or its synonyms and 2365 sentences about the course for sentiments detection of students and top of words that describe opinions with positive and negative polarities and the issues during learning.

Facial recognition technology is named one of the main trends of recent years. It's wide range of applications, such as access control, biometrics, video surveillance and many other interactive human-machine systems. Facial landmarks can be described as key characteristics of the human face. Commonly found landmarks are, for example, eyes, nose or mouth corners. Analyzing these key points is useful for a variety of computer vision use cases, including biometrics,

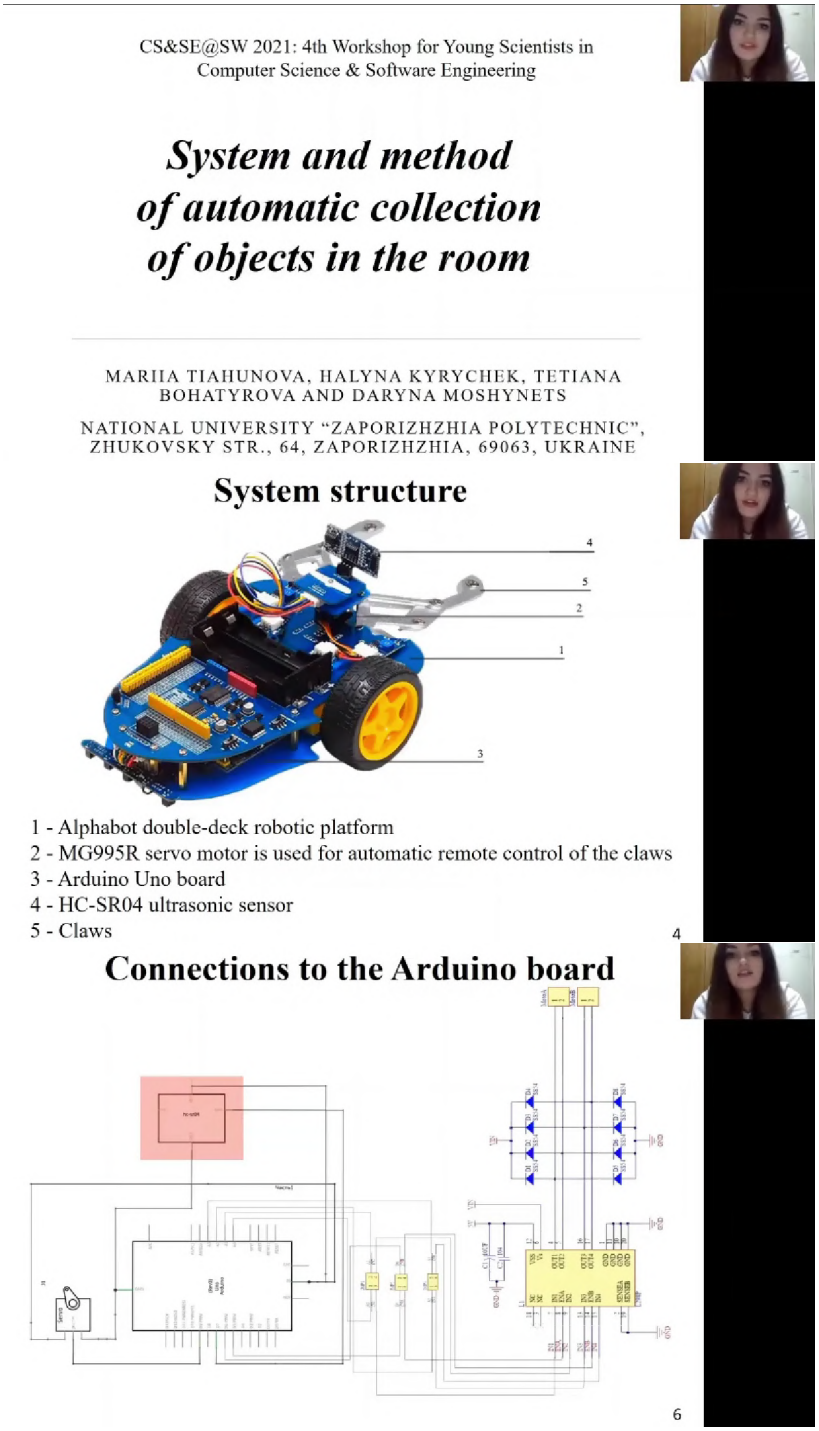

Figure 16: Presentation of paper [9].

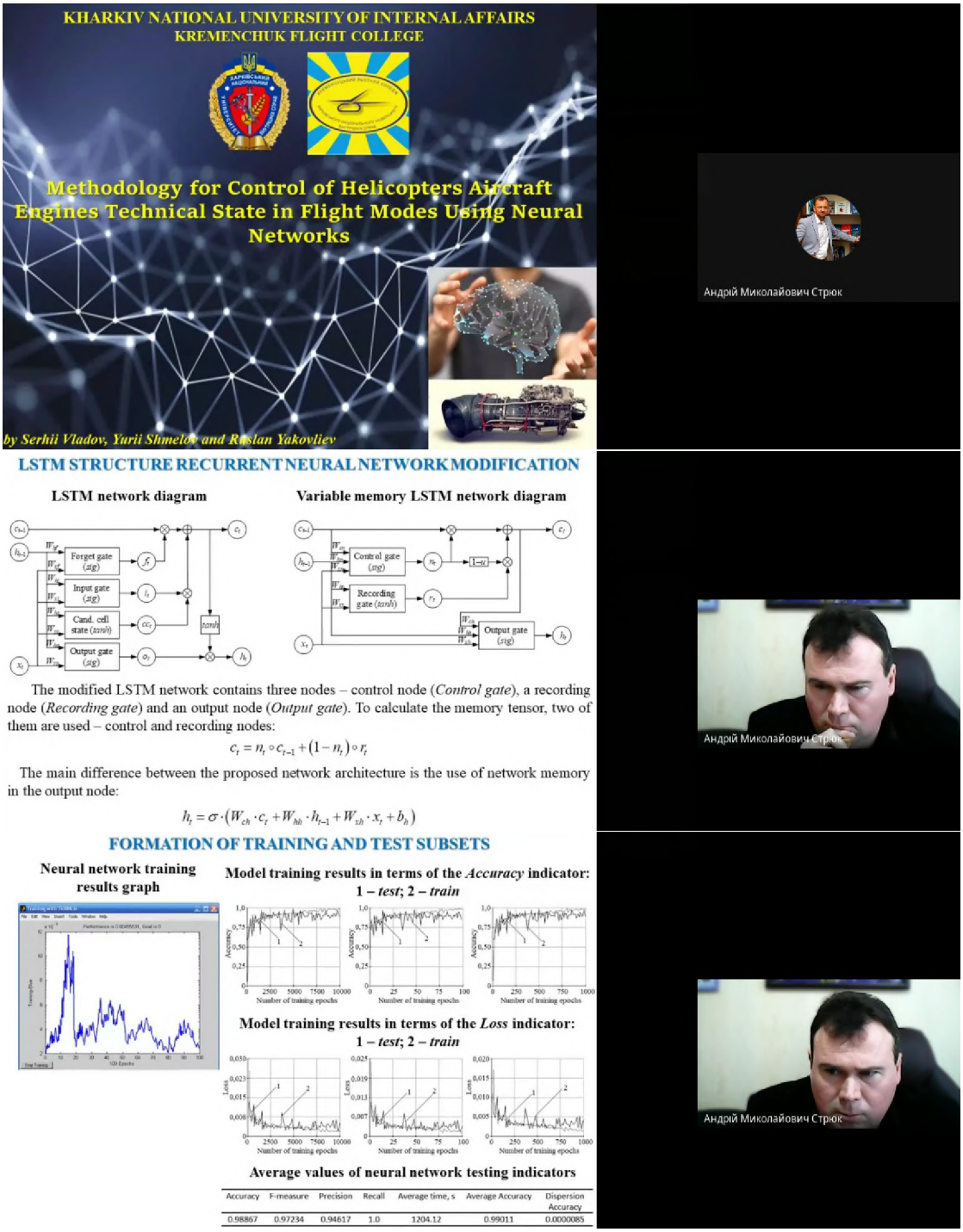

Figure 17: Presentation of paper [12].

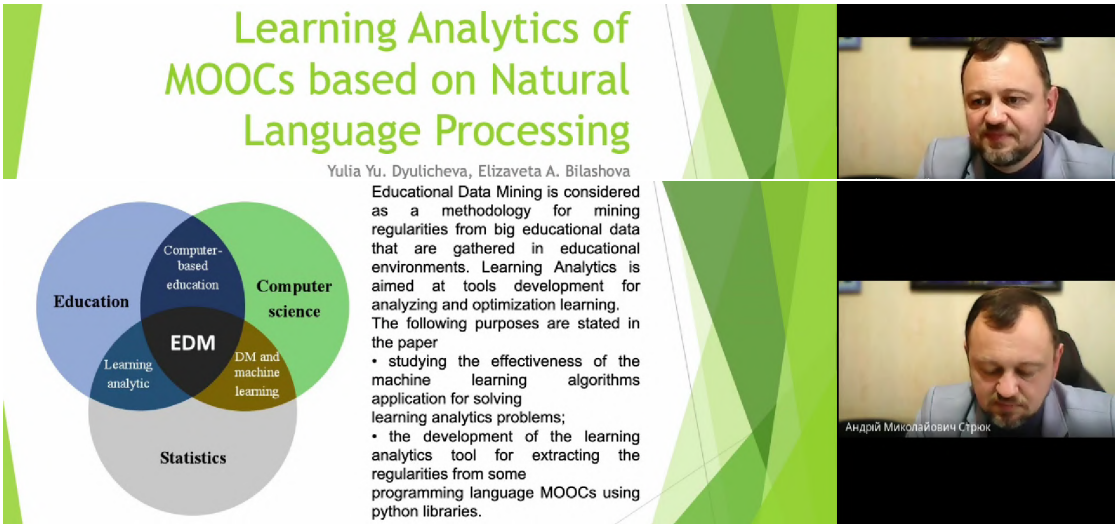

Figure 18: Presentation of paper [10].

face tracking, or emotion detection. Different methods produce different facial landmarks. Some methods use only basic facial landmarks, while others bring out more detail. Elena Yu. Tarasova (figure 19) and Iryna S. Mintii use 68 facial markup, which is a common format for many datasets. Cloud computing creates all the necessary conditions for the successful implementation of even the most complex tasks. Authors created a web application using the Django framework, Python language, OpenCV and Dlib libraries to recognize faces in the image. The purpose of the article "Web application for facial wrinkle recognition" [14] is to create a software system for face recognition in the photo and identify wrinkles on the face. The algorithm for determining the presence and location of various types of wrinkles and determining their geometric determination on the face is programmed.

This article highlights further research by the authors, begun in [72, 73, 74, 75, 76, 77, 78].

5. CS&SE@SW 2021: Conclusion and outlook

The vision of the CS&SE@SW 2021 is provides an expert environment for young researchers, who are at the beginning of their career, to present and discuss the most recent of ideas and early results of research projects. Young researchers, who will join us to take part in discussions and/or present their papers, will be offered an opportunity to exchange and discuss their research ideas with their peers, supervisors, and senior scientists working in the fields that are within the scope of CS&SE@SW.

The fourth installment of CS&SE@SW was organized by Kryvyi Rih National University, Ukraine (with support of the rector Mykola I. Stupnik) in collaboration with Kryvyi Rih State Pedagogical University, Ukraine (with support of the rector Yaroslav V. Shramko), Institute of Information Technologies and Learning Tools of the NAES of Ukraine (with support of the director Valeriy Yu. Bykov), University of Educational Management (with support of the

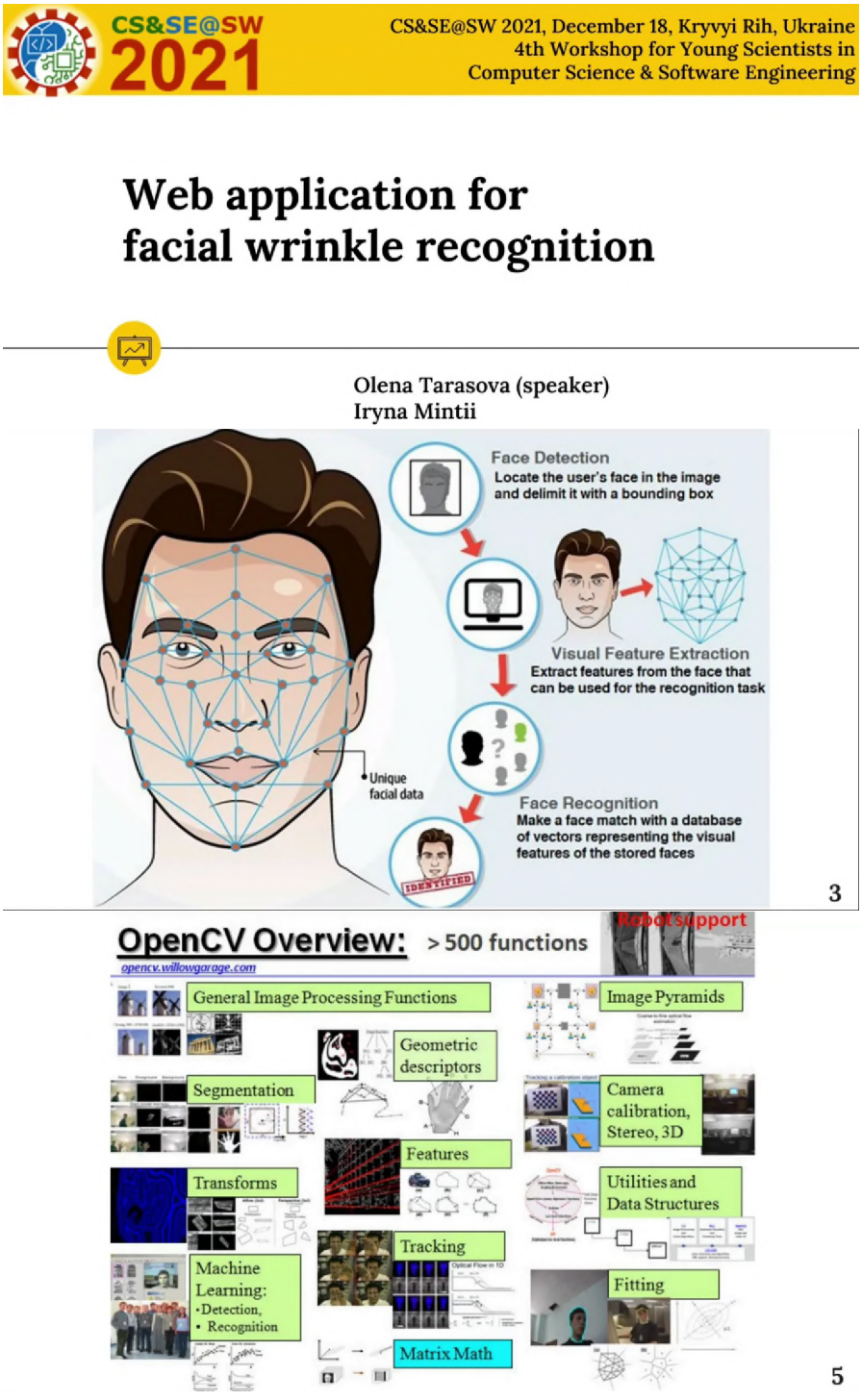

Figure 19: Presentation of paper [14].

vice-rector for research and digitalization Oleg M. Spirin) and Ben-Gurion University of the Negev, Israel (with support of the rector Chaim J. Hames).

We are thankful to all the authors who submitted papers and the delegates for their participation and their interest in CS&SE@SW as a platform to share their ideas and innovation. Also, we are also thankful to all the program committee members for providing continuous guidance and efforts taken by peer reviewers contributed to improve the quality of papers provided constructive critical comments, improvements and corrections to the authors are gratefully appreciated for their contribution to the success of the workshop.

We hope you enjoy this workshop and meet again in more friendly, hilarious, and happiness of further CS&SE@SW 2022 at Kryvyi Rih, Ukraine on December 16, 2022.

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