

# foi

UNIVERSITY OF ZAGREB  
FACULTY OF  
ORGANIZATION  
AND INFORMATICS  
V A R A Ž D I N

ISSN 1847-2001 (Print)  
ISSN 1848-2295 (Online)

# Central European **CONFERENCE** on Information and Intelligent Systems

## Proceedings

35<sup>th</sup> International Scientific Conference

 **CECIIS**

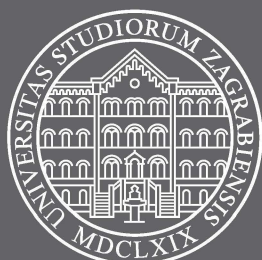
Organized by:

University of Zagreb

**Faculty of Organization and Informatics**

September 18-20/2024

**Varaždin, Croatia**





ISSN 1847-2001 (Print)  
ISSN 1848-2295 (Online)

UDC 004:007

35<sup>th</sup> International Scientific Conference

# Central European Conference on Information and Intelligent Systems



Proceedings

September 18<sup>th</sup> – 20<sup>th</sup>, 2024

**Varaždin, Croatia**

Organized by:  
University of Zagreb  
**Faculty of Organization and Informatics**

## **Publisher**

University of Zagreb Faculty of Organization and Informatics, Pavlinska 2, HR-42000 Varaždin, Croatia

## **For Publisher**

Marina Klačmer Čalopa, University of Zagreb Faculty of Organization and Informatics, Croatia

## **Editors**

Neven Vrčec, University of Zagreb Faculty of Organization and Informatics, Croatia

Dina Korent, University of Zagreb Faculty of Organization and Informatics, Croatia

## **Contact**

E-mail: [ceciis@foi.unizg.hr](mailto:ceciis@foi.unizg.hr)

Phone: +385 42 390 835

Web: [ceciis.foi.hr](http://ceciis.foi.hr)

Fb: [facebook.com/ceciis.foi](https://facebook.com/ceciis.foi)

## **Editorial Board**

Igor Balaban, University of Zagreb, Croatia

Nina Begičević Ređep, University of Zagreb, Croatia

Marko Bohanec, Jožef Stefan Institute, Slovenia

Emer. Leo Budin, University of Zagreb, Croatia

Tonči Carić, University of Zagreb, Croatia

Carlos Carrascosa, Universitat Politècnica de València, Spain

Aruna Chandra, Indiana State University, USA

Luis de Marcos, University of Alcalá, Spain

Blaženka Divjak, University of Zagreb, Croatia

Jasminka Dobša, University of Zagreb, Croatia

Juraj Ďuďák, Slovak University of Technology in Bratislava, Slovakia

Matjaž Gams, Jožef Stefan Institute, Slovenia

Gabriel Gašpar, Slovak University of Technology in Bratislava, Slovakia

Gordan Gledec, University of Zagreb, Croatia

Andrina Granić, University of Split, Croatia

Lourdes Guàrdia, Open University of Catalonia, Spain

Marjan Heričko, University of Maribor, Slovenia

Dieter Hertweck, Herman Hollerith Research Centre, Germany

Edouard Ivanjko, University of Zagreb, Croatia

Dimitris Karagiannis, University of Vienna, Austria

Marina Klačmer Čalopa, University of Zagreb, Croatia

Michal Kohani, University of Žilina, Slovakia

Mario Konecki, University of Zagreb, Croatia

Vladimir Kovšca, University of Zagreb, Croatia

Marjan Krašna, University of Maribor, Slovenia

Alen Lovrenčić, University of Zagreb, Croatia

Sandra Lovrenčić, University of Zagreb, Croatia

Ivan Luković, University of Belgrade, Serbia

Ivan Magdalenić, University of Zagreb, Croatia

Aleksandar Marković, University of Belgrade, Serbia

Peter Marton, University of Žilina, Slovakia

Marta Mas Machuca, UIC Barcelona, Spain

Dunja Mladenović, Jožef Stefan Institute, Slovenia

Oliver Moravčík, Slovak University of Technology, Slovakia

Enrique Mu, Carlow University, USA

Karlo Nyarko, University of Osijek, Croatia

Jan Paralič, Technical University of Košice, Slovakia

Elisabeth Pergler, CAMPUS 02 - University of Applied Sciences, Austria

Emer. Wolf Rauch, University of Graz, Austria

Sonja Ristić, University of Novi Sad, Serbia

Markus Schatten, University of Zagreb, Croatia

Zlatko Stapić, University of Zagreb, Croatia

William Steingartner, Technical University of Košice, Slovakia

Nebojša Stojčić, University of Dubrovnik, Croatia

Vjeran Strahonja, University of Zagreb, Croatia

Diana Šimić, University of Zagreb, Croatia

Marko Tadić, University of Zagreb, Croatia

Martina Tomičić Furjan, University of Zagreb, Croatia

Katarina Tomičić Pupek, University of Zagreb, Croatia

Jan Tretmans, Radboud University Nijmegen, Netherlands

Wim Van Petegem, KU Leuven, Belgium

Violeta Vidaček Hainš, University of Zagreb, Croatia

Sirje Virkus, Tallinn University, Estonia

Mladen Vouk, North Carolina State University, USA

## **Publishing Board**

Marko Matus, University of Zagreb Faculty of Organization and Informatics, Croatia

Jelena Gusić Mundar, University of Zagreb Faculty of Organization and Informatics, Croatia

Lea Masnec, University of Zagreb Faculty of Organization and Informatics, Croatia

Bernarda Kos, University of Zagreb Faculty of Organization and Informatics, Croatia

## **The 35th Central Conference on Information and Intelligent Systems is held under the patronage of the President of the Republic of Croatia Zoran Milanović.**

All rights reserved. No parts of this publication may be reproduced, stored in a retrieval system or transmitted in any form by any means, electronic, mechanical photocopying, recording or otherwise without the prior permission of the copyright owner.

CECIIS Proceedings have been indexed in the following databases: ProQuest (SciTech Premium Collection, ProQuest Technology Collection and ProQuest Advanced Technologies & Aerospace database) and Web of Science.

ISSN 1847-2001 (Print)  
ISSN 1848-2295 (Online)



### **Creative Commons Licence**

Central European Conference on Information and Intelligent Systems Proceedings is licensed under a Creative Commons Attribution-NonCommercialNoDerivatives 4.0 International License.  
<http://creativecommons.org/licenses/by-nc-nd/4.0/>

# Contents

Index of Authors	V
List of Reviewers	VII
Preface	IX

## Computer Games

Bogdan Okreša Đurić, Pasqual Martí, Jaume Jordan, Tomislav Peharda, Vicente Julian <b>Towards Identifying Social Gamification Techniques Applicable to Groups, Applied to On-Demand Shared Transportation</b>	3
Bogdan Okreša Đurić, Ana Kutnjak, Larisa Hrustek, Jože M. Rožanec, Francisco Enguix <b>Towards a Gamification-Enhanced Agent-Based Simulations for the Digital Transformation Process</b>	11
Josmario Albuquerque, Bart Rienties, Sebastian Hähnel, Kristina Cordero <b>Understanding engagement patterns of game-based learning for children in CatnClever using learning analytics</b>	19
Sandra Sačarić, Markus Schatten <b>Integrating Cognitive Agents into Visual Novels</b>	27
Nikola Vlahović, Jasmina Pivar, Ivan Celić <b>Public Funding Approaches to Video Game Industry Development in EU Member States</b>	33
Antonela Devčić, Mihaela Sabol <b>Exploring Hypersexualization in Video Games: A Literature Review of Female Characters</b>	41

## Cyber-Physical and Embedded Systems

Ivan Sládek, Gabriel Gašpar, Juraj Repka, Roman Budjač <b>Stereo Vision Based 3D Positioning for Real-Time Control Applications</b>	53
Juraj Ďudák, Jakub Perička, Martin Skovajsa <b>A Lightweight communication protocol for Body Area Networks</b>	61
Roman Budjač, Gabriel Gašpar, Maros Valasek, Martin Barton <b>Proposal for a weather monitoring system utilizing IoT technologies</b>	67
Roman Ruzarovsky, Richard Skýpala, Nikolas Blahušiak, Ján Šido, Martin Csekei, Tibor Horák, Peter Střelec <b>Virtual Commissioning of Industrial Robot through Software-in-the-Loop Strategies for Cyber-Physical Systems</b>	75
Marija Kuštelega, Ahmed Shareef, Renata Mekovec <b>The Role of Digital Twins in Future Skill Development</b>	83
Snježana Križanić, Neven Vrček, Matija Habuš <b>From Classroom to Real-World: University Students' Experience in Learning Solidity and Blockchain</b>	91
Matija Habuš, Neven Vrček, Snježana Križanić <b>Optimization of urban road network and digital twins: a literature review</b>	99
Goran Fllinić, Ivan Magdalenić <b>Agile Software Development Life Cycle Model for Internet of Things</b>	107

## Digital Transformation and Corporate Culture

Maja Fatiga, Andrej Ignjatić <b>Digitalization of Monitoring Side Effects Before, During and After Covid-19 Vaccines – Analysis of the Impact of the Pandemic on Reporting Side Effects in Republic of Croatia</b>	115
Robertina Zdjelar, Nikolina Žajdela Hrustek <b>Public Policymakers’ Attitudes on Planning and Implementing Measures for 54+ Population e-Inclusion</b>	123
Mirona Ana Maria Popescu, Andreea Barbu, Larisa Maria Fecioru, Elena-Teodora Miron <b>An Analysis on Digital Public Services in Romania</b>	133

## Innovation, Entrepreneurship and Economic Growth

Marijana Bubanić, Dina Korent <b>Profitability of IT companies in the Republic of Croatia in (non)crisis periods: Skillings-Mack test</b>	143
Leon Šaško, Ivana Fojs, Kristina Detelj <b>The rise of the gaming entrepreneurship – overview of the gaming industry ecosystem, case of Croatia</b>	157
Zrinka Lacković Vincek, Suzana Keglević Kozjak, Vladimir Kovšca <b>More than twenty years of the eXtensible Business Reporting Language</b>	165
Tamara Šmaguc, Marina Klačmer Čalopa, Mirjana Grčić Fabić <b>Phenomenological Inquiry in Entrepreneurship and Small Business with Insights into the Digital Economy Research Context</b>	175
Iva Gregurec, Magdalena Kuštelega, Goran Vlašić <b>Exploring the trend of scientific research of eye-tracking for digital advertising insight – A Bibliometric Analysis</b>	183

## Intelligent Energy

Zvonimir Šimić, Danijel Topić, Marina Dubravac, Hrvoje Kurkutović <b>Using of Battery Storage to Match the Supply and Demand of Electricity in Smart Grids</b>	193
Jakub Perička, Tomáš Meravý, Juraj Ďudák <b>Sustainable Microgrid Networks: Advances and Applications</b>	199

# Intelligent Systems

Jože M. Rožanec, Dunja Mladenčić <b>WaAUROCC: measuring how steep the ROC AUC curve is</b>	209
Barbara Kovačić, Anja Brnjaković, Gaurish Thakkar <b>Beyond Words: Sentiment Analysis of Croatian Language Attitudes</b>	217
Gaurish Thakkar, Vanja Štefanec, Daša Farkaš, Marko Tadić <b>Building a Large Language Model for Moderately Resourced Language: A Case of Croatian</b>	225
Oliver Lohaj, Ján Paralič, Ruslana Buinytska <b>Exploring usability in combining data sources for detecting toxic behavior in social media</b>	233
Ana Meštrović <b>A Review of Methods for Analyzing Online Media Texts Using Large Language Models</b>	241
Lucia Načinović Prskalo <b>Text Analysis Methods for Identifying and Recognizing Gender Bias, Inequality, and Violence in Language: An Overview</b> <b>Metode analize teksta za identifikaciju i prepoznavanje rodne pristranosti, nejednakosti i nasilja u jeziku: Pregled</b>	257
Dino Vlahek, Dijana Oreški <b>Data Spaces in the Republic of Croatia: Potential and Opportunities</b>	277
Ivana Ružić, Igor Balaban <b>Social Robots: Applications, Challenges, and Future Directions - literature review</b>	283

## Learning Analytics, AI and Technologies in Education

Martina Holenko Dlab, Gordan Đurović, Marko Horvat <b>Perception and Use of GenAI Chatbots in Education by Students at the University of Rijeka</b>	293
Patrik Komljenović, Mia Čarapina <b>Tablet Math Application for Supporting Independent Simultaneous Interaction of Colocated Users</b>	303
Sonja Nidogon Višnjčić <b>The relationship between student work and academic success: a case study</b>	311
Marko Matus, Igor Balaban <b>Relationship between factors that contribute to student success in the e-learning environment</b>	319
Barbi Svetec, Blaženka Divjak, Damir Horvat, Katarina Pažur Aničić <b>Predicting the Outcomes of PBL: Comparison of Two Methods</b>	325
Blaženka Divjak, Barbi Svetec, Bart Rienties, Paul Astles, Catriona Matthews, Alexander Tillmann, Michael Eichhorn, Julia Schmitt <b>Prioritizing Learning Outcomes in Different Learning Design Contexts</b>	333
Bojan Radišić, Ivan Dunder, Sanja Seljan <b>Predictive Factors for Completion or Dropping Out of Professional Studies</b>	341
Matija Novak, Marija Maček <b>Student perspectives on using Artificial Intelligence tools for solving programming assignments</b> <b>Perspektiva studenata o korištenju alata umjetne inteligencije za rješavanje programskih zadataka</b>	351

## Strategic Planning and Decision Making

Nikola Kadoić <b>Understanding the Impact of the Voting Model at the Eurovision Song Contest: Why Croatian Baby Lasagna did not win the ESC 2024?</b>	367
Jelena Gusić Munđar, Tena Jagačić, Nikola Kadoić <b>Bridging Theory and Practice: Enhancing Business Decision-Making Course through Project-Based and Work-Based Learning</b>	377
Maja Pušnik, Katja Kous, Boštjan Šumak <b>Enhancing Strategic planning course with operational research methods: a case study for IT students</b>	387

## Trends in Software Engineering

Víctor-Pablo Prado-Sánchez, Adrián Domínguez-Díaz, Daniel Rodríguez, José-Javier Martínez-Herráiz, Luis de-Marcos <b>How can ChatGPT help humans in Dark Web content classification? Assessing GPT models reliability and effects of explanations on human decisions</b>	395
Juraj Dončević, Kristina Čaleta, Marko Horvat, Ivica Botički <b>Mine Action Data Observatory: Tackling Uncertainty and System Longevity with Evolutionary Architecture</b>	403
Miro Zdilar <b>Attribute Based Access Control Metamodel for Spreadsheet Programs</b>	409
Sara Kijanović, Darko Stefanović, Dušanka Dakić, Teodora Vučković <b>Using AI on Open Data: A Systematic Literature Review</b>	417
Michaela Pauriková, Michal Varga, Norbert Adamko <b>Reevaluation of intentions of dynamic agent utilizing BDI reasoning in ABAsim architecture</b>	425
Lea Masnec, Zlatko Stapic, Maja Benkus <b>Bridging Academia and Industry: A Collaborative Approach to Software Development Education</b>	433
Publication Ethics And Malpractice Statement	441
Author Guidelines	445
CECIIS 2024 Sponsors	459
CECIIS 2024 Program and Organizing Committees' Members, Research, Professional Tracks' Chairs and Student Poster and Presentation Section Chair	465



## Index of Authors

- Adamko, Norbert 419  
Albuquerque, Josmarío 19  
Astles, Paul 333  
Balaban, Igor 283, 319  
Barbu, Andreea 133  
Bartoň, Martin 67  
Benkus, Maja 433  
Blahušiak, Nikolas 75  
Botički, Ivica 403  
Brnjaković, Anja 217  
Bubanić, Marijana 143  
Budjač, Roman 53, 67  
Buinytska, Ruslana 233  
Celić, Ivan 33  
Cordero, Kristina 19  
Csekei, Martin 75  
Čarapina, Mia 303  
Čaleta, Kristina 403  
Dakić, Dušanka 417  
de Marcos, Luis 395  
Detelj, Kristina 157  
Devčić, Antonela 41  
Divjak, Blaženka 325, 333  
Domínguez-Díaz, Adrián 395  
Dončević, Juraj 403  
Dubravac, Marina 193  
Đudák, Juraj 61, 199  
Dunđer, Ivan 341  
Đurović, Gordan 293  
Eichhorn, Michael 333  
Enguix, Francisco 11  
Farkaš, Daša 225  
Fatiga, Maja 115  
Fecioru, Larisa Maria 133  
Filinić, Goran 107  
Fojs, Ivana 157  
Gašpar, Gabriel 53, 67  
Grčić Fabić, Mirjana 175  
Gregurec, Iva 183  
Gusić Mundar, Jelena 377  
Habuš, Matija 91, 99  
Hähnel, Sebastian 19  
Holenko Dlab, Martina 293  
Horák, Tibor 75  
Horvat, Damir 325  
Horvat, Marko 293, 403  
Hrustek, Larisa 11  
Ignjatić, Andrej 115  
Jagačić, Tena 377  
Jordan, Jaume 3  
Julian, Vicente 3  
Kadoić, Nikola 367, 377  
Keglević Kozjak, Suzana 165  
Kijanović, Sara 417  
Klačmer Čalopa, Marina 175  
Komljenović, Patrik 303  
Korent, Dina 143  
Kous, Katja 387  
Kovačić, Barbara 217  
Kovšca, Vladimir 165  
Križanić, Snježana 91, 99  
Kurkutović, Hrvoje 193  
Kuštelega, Magdalena 183  
Kuštelega, Marija 83  
Kutnjak, Ana 11  
Lacković Vincek, Zrinka 165  
Lohaj, Oliver 233  
Maček, Marija 351  
Magdalenić, Ivan 107  
Martí, Pasqual 3  
Martínez-Herráiz, José-Javier 395  
Masnec, Lea 433  
Matthews, Catriona 333  
Matus, Marko 319  
Mekovec, Renata 83  
Meravý, Tomáš 199  
Meštrović, Ana 241  
Miron, Elena-Teodora 133  
Mladenić, Dunja 209  
Načinović Prskalo, Lucia 257  
Nidogon Višnjic, Sonja 311  
Novak, Matija 351  
Okreša Đurić, Bogdan 3, 11  
Oreški, Dijana 277  
Paralić, Ján 233  
Pauriková, Michaela 425  
Pažur Aničić, Katarina 325  
Peharda, Tomislav 3  
Perička, Jakub 61, 199  
Pivar, Jasmina 33  
Popescu, Mirona Ana Maria 133  
Prado Sánchez, Víctor-Pablo 395  
Pušnik, Maja 387  
Radišić, Bojan 341  
Repka, Juraj 53  
Rienties, Bart 19, 333  
Rodríguez, Daniel 395  
Rožanec, Jože M. 11, 209  
Ružarovský, Roman 75  
Ružić, Ivana 283  
Sabol, Mihaela 41  
Sačarić, Sandra 27  
Schatten, Markus 3, 27  
Schmitt, Julia 333  
Seljan, Sanja 341  
Shareef, Ahmed 83  
Skovajsa, Martin 61  
Skýpala, Richard 75  
Sládek, Ivan 53  
Stapić, Zlatko 433  
Stefanović, Darko 417  
Střelec, Peter 75  
Svetec, Barbi 325, 333  
Šaško, Leon 157  
Šido, Ján 75  
Šimić, Zvonimir 193  
Šmaguc, Tamara 17 5  
Štefanec, Vanja 22 5  
Šumak, Boštjan 387  
Tadić, Marko 225  
Thakkar, Gaurish 217, 225  
Tillmann, Alexander 333  
Topić, Danijel 193  
Valášek, Maroš 67  
Varga, Michal 425  
Vlahek, Dino 277  
Vlahović, Nikola 33  
Vlašić, Goran 183  
Vrček, Neven 91, 99  
Vučković, Teodora 417  
Zdilar, Miro 409  
Zdjelar, Robertina 123  
Žajdela Hrustek, Nikolina 123



## List of Reviewers

Barać, Dušan, Serbia  
Barreto, Nuno Vicente, Great Britain  
Beliga, Slobodan, Croatia  
Bidlo, Michal, Czech Republic  
Bohanec, Marko, Slovenia  
Bubanić, Marijana, Croatia  
Buchem, Ilone, Germany  
Castañeda Quintero, Linda Johanna, Spain  
Ćukušić, Maja, Croatia  
Cvetokoska, Violeta, North Macedonia  
Davalas, Athanasios, Greece  
de-Marcos, Luis, Spain  
Dobrović, Željko, Croatia  
Domínguez-Díaz, Adrián, Spain  
Dudáš, Adam, Slovakia  
Fertalj, Krešimir, Croatia  
Fodor, Lidija, Serbia  
Grd, Petra, Croatia  
Gregurec, Iva, Croatia  
Guajardo, Ashley ML, United States of America  
Guardia Ortiz, Lourdes, Spain  
Hajdin, Goran, Croatia  
Hernández, Luis, Spain  
Horvat, Marko, Croatia  
Hrgarek Lechner, Nadica, Croatia  
Ivković, Nikola, Croatia  
Jagušt, Tomislav, Croatia  
Kadoić, Nikola, Croatia  
Keglević Kozjak, Suzana, Croatia  
Knežević, Goran, Croatia  
Konecki, Mladen, Croatia  
Krašna, Marjan, Slovenia  
Krhač Andrašec, Eva, Slovenia  
Kučina Softić, Sandra, Croatia  
Kumar Cherukuri, Aswani, India  
Kvet, Michal, Slovakia  
Lacković Vincek, Zrinka, Croatia  
Maclaren, Iain, Ireland  
Magdalenčić, Ivan, Croatia  
Maina, Marcelo, Spain  
Mangiron, Carme, Spain  
Martinčić - Ipšić, Sanda, Croatia  
Mekovec, Renata, Croatia  
Meštrović, Ana, Croatia  
Mijač, Tea, Croatia  
Milić, Luka, Croatia  
Milić, Miloš, Serbia  
Nikolić, Dejana, Croatia  
Novak, Matija, Croatia  
Novotný, Samuel, Slovakia  
Nyarko, Emmanuel Karlo, Croatia  
Okreša Đurić, Bogdan, Croatia  
Oreški, Dijana, Croatia  
Paralič, Jan, Slovakia  
Pataki, Norbert, Hungary  
Pavlin, Samo, Slovenia  
Pažur Aničić, Katarina, Croatia  
Perković, Sonja, Denmark  
Pihir, Igor, Croatia  
Poščić, Patrizia, Croatia  
Prunera, Jaume Jordan, Spain  
Pušnik, Maja, Slovenia  
Radaković, Davorka, Serbia  
Radošević, Danijel, Croatia  
Radovanović, Sandro, Serbia  
Rakun, Jurij, Slovenia  
Ristić, Sonja, Serbia  
Rodič, Blaž, Slovenia  
Rodríguez García, Daniel, Spain  
Rožanec, Jože M., Slovenia  
Schatten, Markus, Croatia  
Seme, Sebastijan, Slovenia  
Siedlecka-Lamch, Olga, Poland  
Sittar, Abdul, Slovenia  
Stefanović, Darko, Serbia  
Steingartner, William, Slovakia  
Straka, Milan, Slovakia  
Sturm, Jan, Slovenia  
Szymoniak, Sabina, Poland  
Šarac, Vasilija, North Macedonia  
Tokarčíková, Emese, Slovakia  
Tomaš, Boris, Ireland  
Tomičić, Igor, Croatia  
Topal, Oleksandra, Slovenia  
Umek, Lan, Slovenia  
Van Petegem, Wim, Belgium  
Varga, Michal, Slovakia  
Virkus, Sirje, Estonia  
Vrček, Neven, Croatia



# Preface

We are pleased to present you with the Proceedings of the 2024 Central European Conference on Information and Intelligent Systems. We trust that this compilation will prove to be both valuable and inspiring to you.

Contained within these Proceedings are the full text conference papers from this year's edition of the Central European Conference on Information and Intelligent Systems (CECIIS), an annual international event. This conference is organized by the **Faculty of Organization and Informatics Varaždin, Croatia**. For over three decades, CECIIS has successfully convened with the aim of serving as an interface between scholars and professionals in the field of information and intelligent systems and related domains. This year CECIIS took place from **September 18<sup>th</sup> to 20<sup>th</sup>, 2024**, in Varaždin, Croatia, and was held under the **high patronage of the President of the Republic of Croatia, Mr. Zoran Milanović**. The official language of the conference is English.

With the thematic focus of **“Cyber Physical and Embedded Systems”** CECIIS 2024 was designed to facilitate scholarly exploration and discourse on the transformative opportunities and challenges these systems present to the economy and the society. Considering the role these systems are playing in re-shaping technology and engineering, it is crucial to explore the synergy between hardware and software in this fascinating emerging landscape. At our conference, we discussed how these systems are revolutionizing industries and the society in general. The exploration of cutting-edge topics like AI integration, IoT advancements, and security challenges in embedded systems offered a unique glimpse into the future where the technology is seamlessly integrated with the physical world. A number of workshops was also held on various aspects of the interaction between modern society and technology:

- **WORKSHOP: SMART HOME LIVING**, Slovak University of Technology, Faculty of Materials Science and Technology in Trnava;
- **WORKSHOP: AN EXAMPLE OF BUILDING AND RUNNING THE RAG (RETRIEVAL AUGMENTED GENERATION) APPLICATION WITH ORACLE AI VECTOR SEARCH**, Oracle Company;
- **HELA WORKSHOP: AGILITY IN PLANNING AND DECISION-MAKING IN HE – Project: Improving HEI Maturity to Implement Learning Analytics**;
- **CUTIE WORKSHOP: HOW TO IMPROVE TEACHERS' DIGITAL SKILLS IN CO-CREATION WITH STUDENTS? – Project: Competences for Universities using Technology in Education and Institutional Empowerment**;
- **TRUELA WORKSHOP: RESEARCH WORKSHOP ON TRUSTWORTHY LEARNING ANALYTICS AND AI ALGORITHMS – Project: Trustworthy Learning Analytics and Artificial Intelligence for Sound Learning Design**;
- **DECIDE WORKSHOP: WORKSHOP ON DECIDE METHODOLOGY – Project: Digital Services for the Circular Economy**.

Admittedly, a single conference cannot address all the compelling questions surrounding the use of information technology in modern society. However, we are cultivating a community that is not merely observing the future but actively shaping it through **innovative research, interdisciplinary collaboration, and visionary thinking**. In this way, we remain at the forefront of a technological revolution that is steering the world toward a smarter, more connected future.

It is also pertinent to emphasize that the convergence of Program and Organizing Committee members, academics, and experts from diverse fields allows us to create a cross-disciplinary approach of the conference. This format propels discussions towards topics poised to emerge prominently in the near future, while concurrently facilitating valuable networking among individuals with varied domains of expertise whose collective insights contribute a substantial value to the fabric of CECIIS.

The Proceedings of CECIIS 2024 encompass 49 meticulously reviewed scientific papers. These papers were subject to rigorous peer review by no fewer than two independent evaluators and subsequently endorsed by the international Program Committee. The papers span an array of categories including Computer Games, Cyber-Physical and Embedded Systems, Digital Transformation and Corporate Culture, Innovation, Entrepreneurship and Economic Growth, Intelligent Energy, Intelligent Systems, Learning Analytics, AI and Technologies in Education, Strategic Planning and Decision Making, and Trends in Software Engineering. The selection of these papers hinged upon their relevance, innovativeness, applicability to the information and intelligent systems domain, and overall scholarly merit.

The review process was conducted with the dedicated efforts of **89 reviewers**, 36 from Croatia and 53 from abroad. Collectively, they completed 108 reviews, leading to the acceptance of 49 papers. These papers, authored by 133 individuals representing **10 nations**, were presented at the conference. Following the event, a selected group of papers will undergo further review, potentially leading to extended publication in the **Journal of Organizational and Information Sciences (JIOS)**, the international scientific journal published by the Faculty of Organization and Informatics.

A pivotal hallmark of this year's conference were the distinguished invited **keynote speakers**, individuals whose intellectual contributions have shaped their respective spheres of scientific and professional inquiry. CECIIS 2024 was honored to host the following keynote speakers:

Professor Srđan Čapkun, Ph.D., who addressed the topic "Physical-layer attacks and their impact on wireless networks: two case studies". Dr. Srđan Čapkun is a full professor in the Department of Computer Science, ETH Zurich, and the Chair of the Zurich Information Security and Privacy Center (ZISC).

Professor Hanni Muukkonen, Ph.D., who presented the topic "Stakeholder perspectives of learning analytics and AI development and implementation in education". Dr. Hanni Muukkonen is a Professor in Educational Psychology at the Faculty of Education and Psychology, University of Oulu, Finland. Her research focuses on collaborative learning, knowledge creation, learning analytics, and ethics in AI.

Professor Bart Rienties, Ph.D., who presented the topic "Why culture matters in Information and Intelligent Systems". Dr. Bart Rienties is a Professor of Learning Analytics and Programme Lead of the learning analytics and learning design research programme at the Institute of Educational Technology at the Open University, UK.

In addition to the scholarly sessions, the conference featured two sections dedicated to posters and presentations, which included **2 scientific research posters and 18 student posters and presentations**, collectively involving 39 authors from 7 nations. These sections added depth and diversity to the intellectual landscape of the conference. The student section was further enriched by an invited lecture delivered by Professor Machdel Matthee from the University of Pretoria on the topic of "Digital disruption, digital innovation, and 21st century skills".

A particularly engaging component of the program was the panel discussion entitled "**It's time for digital growth**", moderated by Professor Neven Vrček, Ph.D., from the University of Zagreb Faculty of Organization and Informatics. Esteemed panelists shared their insights on the application of **Industry 4.0 technologies** to stimulate economic growth. The topics covered included **novel economic growth opportunities**, the role of **digital technologies**, rising **security risks in the digital economy**, **sustainability and environmental challenges**, the importance of **strategic focus at the country level**, and how the **scientific community** can contribute to advancing processes related to digital growth.

We extend our sincere thanks to all contributors to the Conference program and these Proceedings. This encompasses our esteemed keynote speakers, panelists, authors, reviewers, session chairs, workshop organizers as well as the Program and Organizing Committee members, whose dedication was instrumental. The formidable support rendered by the Faculty of Organization and Informatics underpins the unequivocal success of the conference.

Lastly, profound appreciation is conveyed to our respected academic and industrial partners, sponsors and donors, whose unwavering support made CECIIS 2024 a resounding achievement. Collaboration with the University of Zagreb Faculty of Transport and Traffic Sciences, University of Zagreb Faculty of Electrical Engineering and Computing, Josip Juraj Strossmayer University of Osijek Faculty of Electrical Engineering, Computer Science and Information Technology, and University of Rijeka Faculty of Informatics and Digital Technologies was central to the realization of the conference. The financial support from sponsors and donors including Oracle d.o.o., Infodom d.o.o., Grad Novi Marof, Hrvatska banka za obnovu i razvitak, Hrvatska elektroprivreda d.d., Grad Varaždin, Varaždinska županija, AGGERO d.o.o., Factory X d.o.o., Jadranski naftovod d.d., Termoplin d.d. Varaždin, Grad Čakovec, Stolarija i pilana Ratković, and Hidroing d.o.o. was also invaluable.

In conclusion, it is our sincerest hope that CECIIS 2024 provided the participants with enriching and productive experience, and that they will find relevant and interesting papers encompassed in these Proceedings. The enduring connections forged with participants over the years reinforce our commitment to continuous improvement. Anticipation is already building for the forthcoming Central European Conference on Information and Intelligent Systems slated for the autumn of 2025.

September 2024

On the behalf of the Program and Organizing Committees

Neven Vrčec and Dina Korent

Editors

## **CECIIS 2024 Sponsors**





CECIIS 2024 GOLD SPONSOR

**INFODOM**

## CECIIS 2024 GOLD SPONSOR

The Oracle logo is displayed in a bold, red, sans-serif font. The word "ORACLE" is written in all caps, with a registered trademark symbol (®) positioned at the top right of the letter "E".

## CECIIS 2024 SILVER SPONSORS

City of Novi Marof



HBOR

## CECIIS 2024 BRONZE SPONSORS



Varaždin County



City of Varaždin

## CECIIS 2024 Program Committee

Neven Vrček, Program Committee Chair, University of Zagreb, Croatia

Victoria Appatova, University of Cincinnati, USA

Igor Balaban, University of Zagreb, Croatia

Nina Begičević Ređep, University of Zagreb, Croatia

Marko Bohanec, Jožef Stefan Institute, Slovenia

Emer. Leo Budin, University of Zagreb, Croatia

Tonči Carić, University of Zagreb, Croatia

Carlos Carrascosa, Universitat Politècnica de València, Spain

Aruna Chandra, Indiana State University, USA

Luis de Marcos, University of Alcalá, Spain

Blaženka Divjak, University of Zagreb, Croatia

Jasminka Dobša, University of Zagreb, Croatia

Juraj Ďuďák, Slovak University of Technology in Bratislava, Slovakia

Matjaž Gams, Jožef Stefan Institute, Slovenia

Gabriel Gašpar, Slovak University of Technology in Bratislava, Slovakia

Gordan Gledec, University of Zagreb, Croatia

Andrina Granić, University of Split, Croatia

Lourdes Guàrdia, Open University of Catalonia, Spain

Marjan Heričko, University of Maribor, Slovenia

Dieter Hertweck, Herman Hollerith Research Centre, Germany

Edouard Ivanjko, University of Zagreb, Croatia

Dimitris Karagiannis, University of Vienna, Austria

Marina Klačmer Čalopa, University of Zagreb, Croatia

Michal Kohani, University of Žilina, Slovakia

Mario Konecki, University of Zagreb, Croatia

Vladimir Kovšca, University of Zagreb, Croatia

Marjan Krašna, University of Maribor, Slovenia

Alen Lovrenčić, University of Zagreb, Croatia

Sandra Lovrenčić, University of Zagreb, Croatia

Ivan Luković, University of Belgrade, Serbia

Ivan Magdalenić, University of Zagreb, Croatia

Aleksandar Marković, University of Belgrade, Serbia

Peter Marton, University of Žilina, Slovakia

Marta Mas Machuca, UIC Barcelona, Spain

Dunja Mladenić, Jožef Stefan Institute, Slovenia

Oliver Moravčik, Slovak University of Technology, Slovakia

Enrique Mu, Carlow University, USA

Karlo Nyarko, University of Osijek, Croatia

Jan Paralič, Technical University of Košice, Slovakia

Elisabeth Pergler, CAMPUS 02 - University of Applied Sciences, Austria

Emer. Wolf Rauch, University of Graz, Austria

Sonja Ristić, University of Novi Sad, Serbia

Markus Schatten, University of Zagreb, Croatia

Zlatko Stapić, University of Zagreb, Croatia

William Steingartner, Technical University of Košice, Slovakia

Nebojša Stojčić, University of Dubrovnik, Croatia

Vjeron Strahonja, University of Zagreb, Croatia

Diana Šimić, University of Zagreb, Croatia

Marko Tadić, University of Zagreb, Croatia

Martina Tomičić Furjan, University of Zagreb, Croatia

Katarina Tomičić Pupek, University of Zagreb, Croatia

Jan Tretmans, Radboud University Nijmegen, Netherlands

Wim Van Petegem, KU Leuven, Belgium

Violeta Vidaček Hainš, University of Zagreb, Croatia

Sirje Virkus, Tallinn University, Estonia

Mladen Vouk, North Carolina State University, USA

## Honorary Members - Former Program Committee Chairs

Tihomir Hunjak, University of Zagreb, Croatia

Mirko Maleković, University of Zagreb, Croatia

Boris Aurer, University of Zagreb, Croatia

## CECIIS 2024 Organizing Committee

Dina Korent, Organizing Committee Chair, University of Zagreb, Croatia

Ena Barčić, University of Zagreb, Croatia

Marijana Bubanić, University of Zagreb, Croatia

Antonela Devčić, University of Zagreb, Croatia

Martina Đuras Sekovanić, University of Zagreb, Croatia

Ivana Fojs, University of Zagreb, Croatia

Lea Masnec, University of Zagreb, Croatia

Marko Matus, University of Zagreb, Croatia

Jelena Gusić Munđar, University of Zagreb, Croatia

Karlo Nadoveza, University of Zagreb, Croatia

Karlo Pepelnik, University of Zagreb, Croatia

Laura Strupar, University of Zagreb, Croatia



## CECIIS 2024 Research Tracks' Chairs

**Computer Games:** Markus Schatten, University of Zagreb, Croatia

**Cyber-Physical and Embedded Systems:** Ivan Magdalenić, University of Zagreb, Croatia

**Digital Transformation and Corporate Culture:** Katarina Tomičić Pupek, University of Zagreb, Croatia

**Innovation, Entrepreneurship and Economic Growth:** Vladimir Kovšca, University of Zagreb, Croatia

**Intelligent Energy:** Danijel Topić, University of Osijek, Croatia

**Intelligent Systems:** Jasminka Dobša, University of Zagreb, Croatia and Dunja Mladenić, Jožef Stefan Institute, Slovenia

**Learning Analytics, AI and Technologies in Education:** Blaženka Divjak, University of Zagreb, Croatia and Igor Balaban, University of Zagreb, Croatia

**Strategic Planning and Decision Making:** Nina Begičević Ređep, University of Zagreb, Croatia

**Trends in Software Engineering:** Marko Mijač, University of Zagreb, Croatia

## CECIIS 2024 Poster Section Chairs

Dina Korent, University of Zagreb, Croatia

Marijana Bubanić, University of Zagreb, Croatia

## CECIIS 2024 Student Poster and Presentation Section Chairs

Violeta Vidaček Hainš, University of Zagreb, Croatia

Victoria Appatova, University of Cincinnati, USA

Antonela Devčić, University of Zagreb, Croatia