



DEEP NEURAL NETWORK MODELS FOR DYNAMIC RESILIENCE ESTIMATION OF A COMPLEX WATER SYSTEM UNDER HAZARDS

Vukašin Ćirović^{1*}, Milan Stojković² and Vladimir Milivojević¹

¹ Jaroslav Cerni Water Institute, Jaroslava Černo 80, 11226 Pinosava, Belgrade, Serbia
e-mail: vukasin.cirovic@jcerni.rs, vladimir.milivojevic@jcerni.rs

² Institute for Artificial Intelligence R&D, Fruškogorska 1, Novi Sad, Serbia
e-mail: milan.stojkovic@ivi.ac.rs

**corresponding author*

Abstract

The paper investigates feed-forward deep neural networks (DNNs) for estimating dynamic resilience of water resource system affected by unpredictable and dangerous events. Besides different architecture of DNNs, hyper-parameters' values were also explored in order to examine the way they affect the performance of DNNs. The aim of this research was to investigate the capabilities of DNNs in domain of water resources resilience estimation to provide significantly better results than currently developed ANN models from literature. The DNN models were trained and tested using large, generated dataset related to the Pirot water system. In order to generate data, an appropriate model of system dynamics was used alongside MonteCarlo simulations. The dataset contained two hazardous events: flood and earthquake defined in wide range of situations (nearly 2,000), from moderate to severe ones. The efficacy of examined DNNs were evaluated using average error metric as well as time required for training and execution.

Keywords: deep neural networks, dynamic resilience, water resources.



Book of Abstracts

**The Third Serbian
International Conference
on Applied Artificial Intelligence
(SICAAI)**

May 23-24, 2024, Kragujevac, Serbia

**The Third Serbian International Conference on Applied Artificial Intelligence, Kragujevac –
Book of Abstracts**

Editor

Professor Nenad Filipović

Technical assistants

Đorđe Ilić

Jelena Živković

Proofreaders

Neda Vidanović Miletić

Milena Đorđević

Publisher

University of Kragujevac, Serbia

Press

DONAT GRAF doo Beograd

Impression

130 copies

Year of publication

2024

ISBN 978-86-81037-79-9

CIP - Каталогизacija у публикацији Народна библиотека Србије, Београд

004.8(048)

**SERBIAN International Conference on Applied Artificial Intelligence (3 ;
2024 ; Kragujevac)**

Book of Abstracts / The Third Serbian International Conference on Applied
Artificial Intelligence, (SICAAI), May 23-24, 2024, Kragujevac, Serbia ; [editor
Nenad Filipović]. - Kragujevac : University, 2024 (Beograd : Donat graf). - 150
str. : ilustr. ; 30 cm

Kor. nasl. - Tiraž 130. - Str. 8-10: Welcome message / Nenad Filipović.

ISBN 978-86-81037-79-9

a) Вештачка интелигенција -- Апстракт

COBISS.SR-ID 144834825

ORGANIZERS

- **University of Kragujevac**



with the support of

- **Ministry of Science, Technological Development and Innovation of the Republic of Serbia**
- **Tecnalia Serbia DOO**



Ministry of Science, Technological Development and Innovation

tecnalia

MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

Technical Co-sponsor

- Serbia and Montenegro Chapter of IEEE Computer Society



Sponsor

- HTEC Group

HTEC

CONTENTS

Organizers	3
Technical Co-sponsor	4
Sponsor	4
Welcome Message	8
Organizing Committee	11
Technical Program	21
Book of Abstracts	31
Physics-informed Neural Networks for Streamlined Snap-through Instability Analysis of Shallow Truss	32
Sustainable Concrete Mix Designs by Machine Learning Approaches	33
Heritage Mining: Theory and Examples	34
Modeling User Behavior in Big Systems	35
Correlation-based Dimensionality Reduction for Multi-source Samples	36
Analysis of Association between Social Media Signals and Stock Return on Asian Markets	37
Influence of Dimensionality Reduction Approaches on Various Machine Learning Models for a Biomedical High-Dimension Dataset	38
Fuzzy-Based Characterization of Ovarian Tumors	39
Advanced Risk Management Practices – The Application of the Exact Solutions Methods for Resilience Factors Improvement	40
Machine Learning-based Prediction of Immunomodulatory Properties of Polymers: Towards a Faster and Easier Development of Anti-inflammatory Biomaterials	41
Deep Neural Network Models for Dynamic Resilience Estimation of a Complex Water System under Hazards	42
Comparing Vision Transformers and Convolutional Neural Networks for Fungi Microscopic Image Classification	43
Turbojet Engine Control with Neural Network-based Feedforward	44
Human Right to Artificial Intelligence: An Alternative Regulatory Framework	45
Application of Recurrent Neural Networks in Assessing Drivers' Oscillatory Comfort during Fore-And-Aft Vibrations	47
Scaling Methodology and Phase Portraits Analysis	48
Parameter Sensitivity Analysis in Multiscale Agent-based Modeling of Atherosclerotic Plaque Progression	49
Efficient Sequential Detection: Enhancing Cancer Detection in Sequential MRI Sequences	51
Text-To-SQL Translation: Application of Deep Learning Approach for Serbian Language	52
Improving Velocity Estimation in GPR Recordings Using Machine Learning Approach	53
Temperature as a Factor Shaping Dissolved Oxygen in the Danube River	54
Deep Learning Segmentation of the Porcine Superficial Femoral Arteries Oct Images	55
Recurrent Neural Networks for Energy Management Systems: A Case Study	56
Dataflow Hardware Advancements for Supporting Artificial Intelligence Algorithms	57
Artificial Intelligence Anxiety among Young Adults in Montenegro	58
Evaluating Bayesian Approaches for Water Quality Classification: A Comparative Study	59
Can Artificial Intelligence Mitigate Intra-Organizational Moral Outrage? A Theory-Based Model	60
Can ChatGPT Write Parallel Code?	61

AI-Powered Prior Art Search: Towards Enriching Intellectual Property Management?	62
Evaluating GDPR and HIPAA in the Integration of ML/AI for Future-Proofing Healthcare	63
AI-Generated Softfakes as Disruptors of Politician-Citizen Interaction: Ethical Considerations.....	64
Applied Artificial Intelligence in Detecting Hate Speech.....	65
Data Analysis Techniques and Detection of Propaganda in Serbian Online Media in 2023	66
Scientific Production and Collaboration Patterns of Medical Researchers: A Case Study in Epidemiology and Infectuous Diseases.....	68
Predicting Electrospun PCL/PEG Nanofiber Diameter Using Artificial Neural Network	69
The Future of Manufacturing: Generative AI and Beyond	70
AI as a Catalyst for Research Talent Development: Elevating Employer Branding to Forge a Cutting-Edge Workforce	71
Factors Influencing AI Prediction of Socially Undesirable Behaviors of Foster Care Children.....	72
A Novel Model for Diversifying AI Based Recommender Systems for Societal Well-Being	73
Transforming Learning: Adapting to Generative AI Technologies in the Serbian Educational Paradigm.....	75
Benchmarking GPT-4 in Sentiment Analysis and Bias Detection: An Evaluation of Advanced Large Language Models in Textual Understanding	76
The Role of Artificial Intelligence in Transforming Hotels in Developing Countries, with a Special Focus on the Republic of Serbia.....	77
Feature Selection for Lying Posture Classification.....	78
Processing of Big Data after Transcriptome Sequencing at Single Cell Resolution.....	80
Multilabel Classification Process Optimization through the Utilization of Transfer Learning Approaches Supported by Decision Postprocessing Techniques	81
Pixels to Prognosis: A Data-Driven Deep Learning Approach for Gastric Cancer Diagnosis	82
Local Execution of Large Language Models: Democratizing AI through On-Device Optimization	83
Automatization of 3D Reconstruction of Coronary Arteries from Angiography Projections using AI-Enhanced Segmentation Techniques	84
The Evaluation of Retrieval Augmented Generation Tasks for Different Large Language Models Fine-Tuned for the Serbian Language	86
Application of Remote Sensing Indices in Vegetation Monitoring	87
Artificial Intelligence-Based Anomaly Detection with Identifying and Mitigating Abnormal Traffic Patterns Associated with the DDOS Attack in Software-Defined Networking	88
How Artificial Intelligence is Transforming Human Resource Management?.....	89
Development of a Convolutional Neural Network for Classification of Heart Sounds Utilizing Mel-Frequency Cepstral Coefficients.....	91
Exploring Machine Learning Approaches for Predicting the Resilience of Water Resources System under Hazardous Events.....	93
AI- and Computer-Based Module for 3D Reconstruction of Patient-Specific Carotid Arteries and Plaque Progression Simulation	94
Adapting All-optical Activation Functions for Predicting Stock Prices on the Frankfurt Stock Exchange.....	96
Community Event Discovery Using ‘X’ Data Stream	97
Folder Design Optimization with Genetic Algorithm for Drug Coated Balloon Folding.....	98
Machine Learning Approach for Predicting Judicial Case Outcome.....	99
Unmanned Vehicles - Technical Perspective of AI Applications and Social Impact	100
Design of New Potential Inhibitor of the GABA _A Receptor Assisted by Artificial Intelligence	101

Development of a Platform for Displaying Medical Results	102
Predicting Absorbance for Different Concentration of AGNPS Using Artificial Neural Network	104
Identification of Potential Biomarkers and Pathways in Dilated Cardiomyopathy Using Bioinformatics Analysis.....	105
Application of Artificial Intelligence in Approximating 2D Hydraulic Calculations	106
Multi-Class Birads Categorization of Mammographs Using Neural Networks.....	107
The Use of Artificial Intelligence in Predicting the Significance of Markers Related to Cell Movement.....	108
AI-Enhanced Extended Reality in Medicine.....	110
Enhanced Biomarker Detection and Health Monitoring Using AI-Driven Multi-Sensor Integration	111
Utilization of Augmented Reality for Improvement of Balance Disorders	113
Overview of the Integration of Genetic Algorithms and Reinforcement Learning Techniques	115
AI-Driven Soil Property Estimation.....	116
Symbolic AI in Verifiable Design of Financial Exchanges	117
Cardiac Segmentation Using UNETR: A Transformer Based Deep Learning Approach on the ACDC Dataset	118
Impact of the Development of Artificial Intelligence on the Stock Market.....	120
The Possibility of Bone Fracture Prediction in Osteoporosis Treatment Through the Use of AI.....	121
A Comparative Study of AutoML Libraries and Hyperparameter Tuning Techniques.....	122
The Impact of Artificial Intelligence on Digital Marketing	123
Exploring Word2Vec Models for Capturing the Similarity of Codon Embeddings	124
On Semantic Association Capabilities of GPT LLMS in a Game of Word Associations.....	125
A Brief Survey of AI-Based Methods in Astrodynamical Problems with Disturbances, Noises and Uncertainties	126
Internet of Medical Things (IOMT): Smart Hearing Aids, Today and Tomorrow	127
Graph Neural Networks and Transformer Embeddings: A Hybrid Approach to Improving Recommender Systems	128
Application of the AHP Method to the Investment Management of Local Municipalities and Countries	129
Evaluation of Using Balanced and Unbalanced Data for Smart City Solution Based on IoT Using Classification and AdaBoostM1.....	130
Multi-Layer Spectral Clustering Algorithm Based on an Adjustment of Laplacian Matrix	131
Treatment of Non-Physical Solutions of the Oxygen Diffusion in Soil by Physics-Informed Neural Network	132
Edge Intelligence for Cybersecurity: AI-Powered Threat Detection in Hardware Infrastructure.....	133
DEEPTech-2M Search Api for Research Funding	134
Evaluation of Magnetized Micro- and Nano-Object Parameters Using Artificial Intelligence	135
AI-Based Intelligence Versus Individual Intelligence: Regarding Designing Better Environmental Policies	136
Comparing Different Approaches for Modelling Soil Properties from Near Infrared Spectroscopy Data	137

WELCOME MESSAGE

Dear colleagues and students,

On behalf of the Organizing Committee, it is a pleasure to welcome you at the Third Serbian International Conference on Applied Artificial Intelligence AAI2024 which takes place in Kragujevac, Serbia, on May 23rd-24th, 2024 at the University of Kragujevac.

AAI2024 provides an exceptional Serbian and international forum to share the state-of-the-art research knowledge and results on the innovative theories, methodology and applications of artificial intelligence and its sub-domain like deep learning, machine learning in different areas such as medicine, economy, education, law, smart city, government, industry etc. Moreover, the conference aims to provide a platform for researchers and practitioners for both academia and industry to share the information about cutting-edge developments in the field of artificial intelligence.

It also aims to:

- provide early-stage researchers with an inspiring event allowing them to connect to relevant experts in related fields;
- provide an exciting venue for researchers to network and establish national and international collaborations;
- bring together leading experts from all relevant scientific domains to enhance the understanding of *Artificial Intelligence*;

Topics cover the following:

AI IN DOMAIN-SPECIFIC APPLICATIONS

- AI in Computational Biology, Medicine and Biomedical Applications
- AI in WWW, Communication, Social Networking, Recommender Systems, Games and E-Commerce
- AI in Finance and Risk Management

AI IN DATA ANALYTICS AND BIG DATA

- Visual Analytics for Big Data
- Computational Modeling for Big Data
- Large-scale Recommendation and Social Media Systems
- Cloud/Grid/Stream Data Mining for Big Velocity Data
- Semantic-based Big Data Mining

MACHINE LEARNING AND DATA MINING

- Pre-processing, Dimension Reduction and Feature Selection Computing, Bayesian and Neural Networks
- Learning Graphical Models and Complex Networks
- Active, Cost-Sensitive, Semi-Supervised, Multi-Instance, Multi-Label and Multi-Task Learning
- Transfer/Adaptive, Rational and Structured Learning

There are seven different mini-symposiums:

- **MS1: AI in Energy and Environmental Science**
Organizers: **Boban Stojanović**, Faculty of Science, University of Kragujevac, Kragujevac, Serbia; **Nikola Milivojević**, Water Institute Jaroslav Cerni, Belgrade, Serbia; **Milan Stojković**, The Institute for Artificial Intelligence R&D of Serbia, Novi Sad, Serbia.
- **MS2: AI & IOT for Smart Industry**
Organizers: **Milovan Medojević**, The Institute for Artificial Intelligence R&D of Serbia, EnergyPulse DOO, Novi Sad, Serbia.
- **MS3: AI in Computer Vision and Remote Sensing**
Organizers: **Marko Pavlović**, The Institute for Artificial Intelligence R&D of Serbia, Novi Sad, Serbia; **Slobodan Ilić**, The Institute for Artificial Intelligence R&D of Serbia, Novi Sad, Serbia; **Dubravko Ćulibrk**, The Institute for Artificial Intelligence R&D of Serbia, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia.
- **MS4: AI and Social Wellbeing**
Organizers: **Ljubiša Bojić**, The Institute for Artificial Intelligence R&D of Serbia, Novi Sad, Serbia; **Milan Ćabarkapa**, Faculty of Engineering, University of Kragujevac, Serbia; **Igor Pantić**, Faculty of Medicine, University of Belgrade, Serbia.
- **MS5: Future of Workforce**
Organizers: **Jelena Ćulibrk**, The Institute for Artificial Intelligence R&D of Serbia, Novi Sad, Serbia; **Bojana Jakanović**, The Faculty of Technical Sciences, University of Novi Sad, Serbia; **Dunja Bošković**, The Faculty of Technical Sciences, University of Novi Sad, Serbia.
- **MS6: Delivering on The Promise of AI to Improve Health Outcomes**
Organizers: **Tijana Geroski**, Faculty of Engineering, University of Kragujevac, Serbia; **Nenad Filipović**, Faculty of Engineering, University of Kragujevac, Serbia.
- **MS7: Heritage Mining: Theory and Examples**
Organizers: **Veljko Milutinović**, Guest Lecturer and Former Faculty, Purdue University, USA Adjunct Professor, University of Indiana in Bloomington, USA, Adjunct Professor, Technical University of Graz, Austria Visiting Professor, University of Kragujevac Visiting Professor, University of Belgrade Visiting Professor, University of Montenegro.

As well as seven world renowned plenary speakers in the area of applied artificial intelligence:

- **Prof. Amir A. Amini** – University of Louisville, Louisville, Kentucky, USA; **Title: 4D Flow MRI: Efficient Acquisition and Deep Learning Strategies for Assessment of Hemodynamics**
- **Prof. Borko Furht** – Florida Atlantic University, Boca Raton, Florida, USA; **Title: Successful Engineering Education Requires Applied Industry Projects**
- **Prof. Themis Exarchos** – Ionian University, Corfu, Greece; **Title: Using Explainable AI (xAI) to Predict the Conversion from Mild Cognitive Impairment to Alzheimer’s Disease**
- **Prof. Emil Jovanov** – University of Alabama at Huntsville, USA; **Title: Integrating AI and IoT for Personalized Healthcare**
- **Prof. Dubravko Ćulibrk** – University of Novi Sad, Novi Sad, Serbia; **Title: AI-disrupted Medicine and How to Apply it in Serbia**
- **Prof. Israel Koren** – University of Massachusetts in Amherst, USA; **Title: Protecting Vehicle Privacy against AI-Enhanced Attackers in Intelligent Transportation Systems**
- **Prof. Zoran Obradović** – Temple University, Philadelphia, Pennsylvania, USA; **Title: Characterizing Disruptive Events by Modeling Dynamics in Multiplex Networks**

We have received more than 180 high-quality research papers. As a result of the strict review process and evaluation, the committee selected over 100 papers as extended abstracts.

After the review, full papers from the AAI2024 conference will be published by Springer Verlag in the series “Learning and Analytics in Intelligent Systems” under the title “Applied Artificial Intelligence”. We must also admit that the conference certainly would not have been so successful without the efforts of many people who were actively engaged in organization of such a major academic event. We express gratitude to the members of the program and scientific review committee as well as to all the chairs, organizers and committee members for their dedication and support. On behalf of the Organizing Committee, we wish you all a pleasant stay in Kragujevac and a productive conference.

Prof. Nenad Filipović, Conference Program Chair

ORGANIZING COMMITTEE

Chair:

- Nenad Filipović, University of Kragujevac

Organizing Committee:

- Martin Aleksandrov (TU Berlin, Germany)
- Sandra Avila (University of Campinas (Unicamp), Brazil)
- Christian Blum (Spanish National Research Council (CSIC), Spain)
- Carlos Cardonha (University of Connecticut, United States)
- Vinay Chaudhri (United States)
- John Chinneck (Carleton University, Canada)
- Andy Chun (City University of Hong Kong, Hong Kong)
- Andre Augusto Cire (University of Toronto, Canada)
- Bradley Clement (Jet Propulsion Laboratory, United States)
- Dubravko Čulibrk (University of Novi Sad, Serbia)
- Veljko Milutinović (University of Kragujevac and University of Belgrade, Serbia)
- Diane Cook (Washington State University, United States)
- Gabriella Cortellessa (CNR-ISTC, National Research Council of Italy, Italy)
- Lizhen Cui (Shandong University, China)
- Akay Metin (University of Houston, USA)
- Allen Robert (University of Southampton, UK)
- Zoran Bosnić (University of Ljubljana, Slovenia)
- Zlatan Car (University of Rijeka, Croatia)
- Ciaccio Edward (Columbia University, USA)
- Themis Exarchos (University of Ioannina, Greece)
- Dimitrios Fotiadis (University of Ioannina, Greece)
- Nikola Jorgovanović (University of Novi Sad, Serbia)
- Zoran Marković (IIT, Serbia)
- Michalopoulos George (University of Pittsburgh, USA)
- Nikita Konstantina (National Technical University of Athens, Greece)
- Zoran Obradović (Temple University, USA)
- Ouzounis Christos (King's College, UK)
- Pattichis Constantinos (University of Cyprus, Cyprus)
- Sheu Phillio (University of California, USA)
- Stojanović Radovan (University of Montenegro, Montenegro)
- Miroslav Trajanović (University of Niš, Serbia)
- Tsiknakis Manolis (Hellenic Mediterranean University, Greece)
- Yang Guang-Zhong (Imperial College London, UK)
- Zervakis Michalis (University of Crete, Greece)
- Andre de Carvalho (University of São Paulo, Brazil)
- Luca Di Gaspero (DPIA – University of Udine, Italy)
- Matthew Gaston (Carnegie Mellon University, United States)
- Carmen Gervet (Université de Montpellier, France)
- Odd Erik Gundersen (Norwegian University of Science and Technology, Norway)
- Koen Hindriks (Vrije Universiteit Amsterdam, Netherlands)
- Neil Jacobstein (Singularity University, United States)
- Binbin Jia (Southeast University, China)
- Elias Khalil (Georgia Institute of Technology, United States)

- Lars Kotthoff (University of Wyoming, United States)
- Hoong Chuin Lau (Singapore Management University, Singapore)
- Jimmy Lee (The Chinese University of Hong Kong, Hong Kong)
- Lee McCluskey (University of Huddersfield, United Kingdom)
- Felipe Meneguzzi (Pontifical Catholic University of Rio Grande do Sul, Brazil)
- Mitra Nasri (Delft University of Technology, Netherlands)
- Barry O'Sullivan (University College Cork, Ireland)
- Michael Orosz (University of Southern California Information Sciences Institute, United States)
- Simon Parsons (University of Lincoln, United Kingdom)
- Andrew Perrault (Harvard University, United States)
- David Pynadath (University of Southern California, United States)
- Claude-Guy Quimper (Laval University, Canada)
- Howard Shrobe (Massachusetts Institute of Technology, United States)
- Madhav Sigdel (University of Alabama in Huntsville, United States)
- David Stracuzzi (Sandia National Laboratories, United States)
- Dimitris Stripelis (University of Southern California, United States)
- Nirmalya Thakur (University of Cincinnati, United States)
- Kevin Tierney (Bielefeld University, Germany)
- Michael Trick (Carnegie Mellon University, United States)
- Pradeep Varakantham (Singapore Management University, Singapore)
- Deng-Bao Wang (Southeast University, China)
- Shinjae Yoo (Brookhaven National Laboratory, United States)
- Yingqian Zhang (Eindhoven University of Technology, Netherlands)
- Dubravko Čulibrk (University of Novi Sad, Serbia)
- Jovan Stojanović (Serbian AI Society, Serbia)
- Stefan Badža (Serbian Government, Serbia)

Local Organization:

- **Tijana Geroski**, University of Kragujevac
- **Smiljana Tomašević**, University of Kragujevac
- **Aleksandra Vulović**, University of Kragujevac
- **Ognjen Pavić**, University of Kragujevac
- **Lazar Dašić**, University of Kragujevac
- **Đorđe Dimitrijević**, University of Kragujevac
- **Milica Kaplarević**, University of Kragujevac
- **Milena Đorđević**, University of Kragujevac
- **Marija Gačić**, University of Kragujevac
- **Neda Vidanović Miletić**, University of Kragujevac
- **Miloš Kojić**, Serbian Academy of Sciences and Arts
- **Miloš Đuran**, Serbian Academy of Sciences and Arts
- **Vesna Ranković**, University of Kragujevac
- **Vladimir Ranković**, University of Kragujevac