EXPLORING MACHINE LEARNING APPROACHES FOR PREDICTING THE RESILIENCE OF WATER RESOURCES SYSTEM UNDER HAZARDOUS EVENTS

Aleksandra Z. Kazaković[1], Višnja M. Simić [2*] and Vukašin B. Ćirović[3]

[1] FIS Serbia, Milutina Milankovića 136B, 11000 Belgrade, Serbia
e-mail: aleksandra.kazakovic@fisglobal.com
[2] Faculty of Science, University of Kragujevac, Radoja Domanovića 12, 34000 Kragujevac, Serbia
e-mail: visnja@kg.ac.rs
[3] Jaroslav Cerni Water Institute, Jaroslava Černog 80, 11226 Pinosava, 11000 Belgrade, Serbia
e-mail: vukasin.cirovic@jcerni.rs
*corresponding author

Abstract

Climate change-induced extreme weather events affect water systems, causing operational challenges and functional failures. Earthquakes and consequential landslides are other common causes of disruption. Assessing system resilience is crucial to avoid the failure of water systems.

This research aimed to explore various approaches in developing a machine learning model to predict the water system's robustness and the system's recovery time from external or internal hazards (rapidity). The dataset was obtained by simulating the system dynamics model and hazard model of the hydroelectric power plant. A thorough examination of the data preceded the model's construction. Random Forest (RF) and Artificial Neural Network (ANN) models were fitted to the training dataset. The ANN model fine-tuned using the Keras-tune approach yielded a high R^2 score. To overcome the imbalanced dataset problem, the synthetic minority oversampling technique (SMOGN) was utilized. Due to highly imbalanced data for the Robustness values over 0.2, even the implementation of the SMOGN technique could not yield an R^2 score over 0.8.

The dataset was also modeled as a classification problem, using K-means clustering to group Robustness and Rapidity values into classes. The best classification model obtained was compared with the existing Fuzzy rule-based model which enables comprehensible reasoning using natural language. Precision, Recall and F1 score values of the ANN Keras-tuned model were better than the same metrics for the fuzzy model, but the explanatory capability was lost.

Keywords: exploratory data analysis, imbalanced data, machine learning.

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

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

MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

6

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 Čabarkapa**, 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 Jokanović**, 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.

9

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