



Book of Abstracts

Workshop on RECI 2024

November 6-8, 2024
Žilina, Slovakia



Co-funded by the
Erasmus+ Programme
of the European Union



Preview

Previous *International Workshops on Reliability Engineering and Computational Intelligence* (RECI 2020 and RECI 2022) demonstrated a strong synergy between Reliability Engineering and Computational Intelligence but scientific differences remain. The third RECI workshop attempts to address further integration by (a) presenting papers on RECI topics, (b) panel discussions about future RECI research, and (c) a curriculum discussion for an international RECI curriculum. Since reliability engineering and computational intelligence include a wide range of scientific and engineering areas, the workshop will be divided into four parts:

- Main Conference
- Stream on Applications of RECI in Healthcare
- Stream on Environmental Risk Assessment
- Stream for PhD Students and Young Researchers (ACeSYRI)

Main Conference. The main conference focuses on all areas of synergy between two scientific domains that are reliability engineering and computational intelligence. Reliability engineering is an established domain that has a very good practical and scientific background for the analysis of the reliability of systems. Computational intelligence is relatively new in reliability engineering. But it has been an equally well-established branch of research with many groups over the world attempting to develop useful computational intelligence tools in different fields. Today, the continuous drive for digitalization causes reliability engineering and computational intelligence to merge. Combining the fields paves the way to progress in big data analytics, uncertain information evaluation, reasoning, prediction, modeling, optimization, decision-making, and of course, more reliable systems. Topics of interest include but are not limited to: Accident and Incident Analysis, Computational Intelligence for Risk Estimation, Data Mining and Knowledge Discovery, Digital Technologies for Reliability Engineering, Hardware and Software Solutions, Human Reliability Analysis, Mathematical and Computational Methods for Risk Analysis, Methods Based on Artificial Intelligence, Risk and Hazard Analysis, Software Solutions for Testing Fault-Tolerant Systems, Software Reliability, Trends in Reliability Engineering and Computational Intelligence, etc.

The main conference of the workshop is organized in accordance with the activities of projects “*Development of a New Approach for Reliability Analysis and Risk Assessment Based on Artificial Intelligence*” (Project APVV-23-0033 supported by the Slovak Research and Development Agency).

The workshop RECI 2024 continues the ideas and achievements of the Reliability and Safety workshop, which was supported by the project “*Exchange Reliability and Safety Experience in the V4 region*” (Visegrad fund, reg.no. 22230200) and by the project “*New Methods Development for Reliability Analysis of Complex Systems*” (Project reg.no. APVV-18-0027 supported by the Slovak Research and Development Agency).

Stream on Reliability Engineering and Computational Intelligence in Healthcare. The aim of the stream is discussion on relevant topics and trends in reliability engineering, data mining, and machine learning in healthcare, medicine, and biotechnologies. The possible areas include but are not limited to Biomedical Engineering, Biomedical Informatics, Computer-Aided Diagnosis, Education in eHealth and Telemedicine, Electronic Health Records and Medical Databases, Innovative eHealth, Precision Medicine, Applications and Products, Legal, Social, Ethical and Financial Aspects, Medical Image Analysis and Biomedical Visualization, Telemedicine, Telehealth and Remote Monitoring, etc.



The stream is organized in accordance with activities of the project “*University-Industry Educational Centre in Advanced Biomedical and Medical Informatics*” (reg.no. 612462-EPP-1-2019-1-SK-EPPKA2-KA supported by the European Union’s Erasmus+ programme). The workshop is also a post-project activity of “*Development of Methods of Healthcare System Risk and Reliability Evaluation under Coronavirus Outbreak*” (reg.no. APVV PP-COVID-20-0013), which was supported by the Slovak Research and Development Agency in years 2020 and 2021.

Stream on Environmental Risk Assessment. The stream focuses on applications of reliability analysis, machine learning and remote sensing in environmental risk assessment. Topics of the stream include Environmental Threats and Environmental Hazards, Geoprocessing and Geographic Information Systems, Land Degradation, Mathematical and Computational Methods for Risk Assessment, Mathematical Models of Environment, Remote Sensing, Use of Unmanned Aerial Vehicles in Environmental Risk Assessment, ArcGIS Application in Environmental Risk Assessment, Cartography and maps development, Risk Assessment in Environment, etc.



The stream is organized in accordance with the activities of the project “*Earth Observation for Early Warning of Land Degradation at the European Frontier (EWALD)*” (Horizon Europe, ID 101086250).

Stream for PhD Students and Young Researchers. The stream covers all topics of the RECI Workshop and provides an opportunity for students, PhD students, and young researchers to present their results based on the submitted abstracts.



The stream is organized in accordance with the post-project activities of “*The Advanced Centre for PhD Students and Young Researchers in Informatics*” (ACeSYRI) (Project EACEA.CBHE reg.no.: 610166-EPP-1-2019-1-SK-EPPKA2-CBHE-JP supported by the European Union’s Erasmus+ programme)

The organization of all workshops is supported by *IEEE Chapter of Reliability Society of the Czechoslovakia Section, the European Safety and Reliability Association (ESRA), the Slovak Research and Development Agency, and the Institute of Information Technologies*



Website of RECI 2024:

<https://reci.fri.uniza.sk>

Table of Contents

From High Reliability to Resiliency Engineering – The Future of Patient Safety.....	9
Reliability Importance Measures: from Local to Global.....	10
Electromobility Transformation: Challenges for Reliability Engineering	10
Defending Complex Systems Against Intentional Attacks and Natural Impacts	11
Some Dynamical Systems for Reliability Modelling and Estimation	11
Advanced Learning from Information in the Chemical Industry	12
Availability Models of a Recoverable Wireless Sensor Network for Forest Fire Monitoring System	13
An Asymmetrical Graph Siamese Network for One-Class Anomaly Detection of Engine Equipment with Multi-Source Fusion	14
2050 Futures in AI: Two Horizons	15
Application of a Bowtie Digital Twin: How a Mechanical Seal Looks Different from a Data Perspective.....	17
Experimental Overview of Techniques Used for the Management of Intermediate Results in Calculations with Decision Diagrams.....	18
Data Potential and Feasibility Study with Grid mean Algorithm	18
Evaluating Ground Impact Severity in Suborbital Vehicle Explosion Scenarios	20
Code Performance Evaluation with Modern AI Models and Fine Tuning.....	21
Estimating Electric Motor Temperatures with Machine Learning Models	23
Advanced Tools for Visualization and Animation in the Simulation and Computational Intelligence	25
Using Intelligent Approaches in Algorithms of Interpolation and Extrapolation of Short-Focus Electron Beams Boundary Trajectories by Root-Polynomial Functions.....	26
A Reinforcement Learning Algorithm based on Markovian Model for Server Reliability Assessment in IIOT System.....	27
Use of ROS2 in Conjunction with YOLOv8 Image Recognition System for Mobile Robot Control System.....	28
Lightweight Convolutional Transformer for Fault Diagnosis on Vibration Signal in Time- Frequency Domain	29
Overview of AI Applications in Electromechanical Systems.....	30
Damage Detection in Road Images By YOLOv9 and Transfer Learning	31
Comparison of Python and Octave as Tools for Developing Intelligent Systems.....	32
The Study of Hardware Resources Usage on Examples of Convolutional Neural Network Implementation.....	33

Digitalization of Urban Systems: Kazakhstan's Experience in Creating Smart Cities	33
Empirical Hardness of the AES Cipher.....	34
Testing Stability of Virtual Machines with Various Strategies of Resource Provisioning	35
Modelling Reliability of Multi-Purpose Synthesis System in Presence of Common-Cause Failures	36
Improving the Reliability of Automatically Generated Test Suites	37
Implementing 3MU Identification in Chaotic Environments	38
Parallel Numerical Simulators for Surrogate Modeling of Random Fields.....	39
Reliability and Maintainability of Technical Systems: Modularisation Versus Overall System. Case Study Electric Vehicles.....	40
Machine Learning Analysis of Potential Mobile APPS Threats on the Basis of Permissions.....	41
Research of Automated Control System of Gravity Enrichment Method of Chrome ORE	42
Sensitivity of Goal Function in R-Facility Interdiction Covering Problem and Systemic Risk.....	43
synTEXT4JSON: Framework for Generating Synthetic Data for Template-Filling Task	44
University Selection System, Problems and Solutions	47
Synthetic Data Generation for Enhancing Specialized Object Detection Models	48
Reducing the Impact of the Reproducibility Crisis on the Ranking of Binary Classifiers through the Examination of Performance Scores' Consistency.....	51
Comparison of Open APIs for the Data Collection on environment Indicator: A Case Study on Air Quality in Almaty, Kazakhstan.....	53
Modeling and Control of a Mobile Robot with Differential Drive Based on a Digital Twin Complete	54
Identification of Thematic Groups of Publication Corpora using Top2Vec.....	57
UAV Flight Planning for Solving Monitoring Problems	58
Using UAVs and Deep Neural Networks to Count the Number of Cars on City Roads	58
Testing Software for Error-Correcting Data Coding at the Processor Level.....	59
LLMAgentNet: A Collaborative Network of Autonomous AI Agents for Complex Task Execution ..	60
Fine-Tuning LLM for Code Style Analysis: An Approach Augmented with DFA	62
Flight Safety Calculations in a Computer Aided Flight Planning System.....	63
On the Use of Offline Reinforcement Learning Methods in Condition-based Maintenance.....	64
Exploring Social Dynamics and Stability Using Cellular Automata	65
Modeling and Optimization of Software Reliability using Fuzzy-Algorithmic Approach	66
Robust Bayesian Method for Step-Stress Accelerated Life Testing Data	67
A Development of Fuzzy Inference System for Modeling the Degradation of Light Emitting Diode	67
Quantifying System Reliability based on Accelerated Life Test Data for Components.....	68
Solid Waste Detection During Monitoring of Urban Agglomerations using UAVs	68

Stages of Planning and Modeling the Bread Baking Process in the Context of Creating a Digital Twin	69
Synchronization of the Time Zones in the Temporal Database Environment Making Transparent Reliable Solution	70
Bayesian Networks as Surrogate Models	70
Stream on <i>Reliability Engineering and Computational Intelligence in Healthcare</i>	71
New Biotechnological Directions in Diagnostics and Treatment of Ischemic Cardiomyopathy	72
CRISPR: A New, Versatile Biotechnology	73
From Genome to Treatment: The Encode Project's Impact on Precision Medicine and Technological Innovations	74
Genetic Aspects of Hereditary Thrombophilia in Pregnancy	75
Technologies for Breast Cancer Diagnosis	76
Biotechnological Progress in Determining Genotypic Diversity and Mutation Profiles of Multidrug-Resistant Mycobacterium Tuberculosis	77
AI, Algorithmic Management and Teachers' Occupational Safety and Health	78
Application of Artificial Intelligence to Enhance the Reliability of Lightweight Cryptographic Systems in Precision Medicine	81
Biotechnological Transplantation of Hematopoietic Stem Cells with Mutation of the CCR5 Gene as a Way of Treating HIV Infection	82
Recent Progress for Determination of Association of Some Periodontal Microorganisms with PD-L1 and PD-1 Protein Expression	83
Medical Image Segmentation with Graph Reasoning	84
Investigating the Relationship between Lighting, Human Circadian Rhythms and Physiological Parameters	85
Integration of eHealth Competences into Health Students' Curriculum	86
Wearable Devices in Cardiovascular Medicine	87
Advances in Gene Therapy for Duchenne Muscular Dystrophy: Promising Strategies and Future Directions	88
New Bioengineering Technologies in the Diagnosis and Treatment of Multiple Sclerosis	89
Recent Biotechnologies to Assess Genetic Factors in Atherosclerosis	90
New Biotechnological Directions in Treatment of Cystic Fibrosis	91
Biotechnologies Improving the Diagnostic Establishment of Molecular Mechanisms Involved into Synaptic Dysfunction of Dopaminergic Neurons in Parkinson's Disease	92
Simulation-based Approaches to Managing Infectious Disease Risks in Conflict Zones: Opportunities and Limitations	93
Biotechnological Development of Targeted Treatments based on a Tumor's Specific Genetic Mutations in PARP Inhibitors	94

Optimization of Parameters for Modeling the Joint Spread of Tuberculosis and HIV Using an Integrated Approach	95
The Classification of ECG signals.....	97
Stream on <i>Environmental Risk Assessment</i>.....	98
A Method to Aggregate Interval-Valued Expert Estimates Taking into Account Their Reliability ..	99
Methodological Foundations of Multispectral Aerospace Images Informativeness Increasing.....	103
Geophysical Methods of Soil Fertility Mapping for Precision Agriculture Applications in Morocco	104
Forward Seismic Modeling and High-Resolution Seismic Imaging of the Phosphatic Series in the Gantour Basin (Morocco)	105
Eo-Based Early Warning System for Enhancing Responses to Land Degradation: Challenges and Solutions.....	106
Functional Block Configuration of EWS for Land Degradation Mapping/Prediction	108
Monitoring Changes in Agricultural Landscapes within the Areas of Municipal Solid Waste Dumps using Remote Sensing and GIS Technologies.....	110
Assessment of Land Degradation and Urbanization in ARID Environments through SDG 11.3.1 and 15.3.1 Indicators	111
Siltation of Recent Large Dams in the Marrakesh-Safi Region, Morocco: Analysis of Factors Influencing Sediment Yield using the RUSLE Model and GIS.	112
Adaptability of Sludge from Industrial Aggregate Processing as a Ceramic Raw Material: A Case Study of the Marrakech Region, Morocco	113
Lithological Mapping Using Multispectral Data and Machine Learning Algorithms: A Case Study from Tighardine Area (Western High Atlas, Morocco)	114
The Use of RUSLE Model and CHIRPS Satellite Precipitation Product for Estimating Soil Loss by Water in a Scarsly Gauged Semi-Arid Area: Case of Central Morocco	115
Sub-Daily Flood Dynamics in Semi-Arid and Arid Basins: A Case Study of Southern Morocco	116
Sediment Pollution by Heavy Metals from Mining Activities: Ecological Risks, Contributors, and Future Research Directions	117
Co-seismic Ground Deformation and Associated Hazards from the 2023 Mw 6.8 Al Haouz Earthquake, Morocco: Analysis of Seismological Data, DInSAR and Geomorphological Surveys	118
Spatiotemporal Characterization and Hydrological Impact of Drought Patterns in Northwestern Morocco	119
Advanced 3D Geo-Environmental Characterization and Modeling for Early Detection and Prevention of Acid Mine Drainage in Coal Mine Waste Rock	120
An Approach to Radar and Optical Imagery Super-Resolution.....	121
Earth Observation Data Warehouse for Land Degradation Mapping/Prediction	123

Environmental Sustainability and Supply Chain Management: Streamline KPI Monitoring Data
Ecosystem..... 124

GIS Software, Different Software Solutions and Their Usage 124

Modeling and Optimization of Software Reliability using Fuzzy-Algorithmic Approach

H.B. Rakytyanska and B.V. Prus

Vinnitsia National Technical University, Ukraine, rakit@vntu.edu.ua, bohdan.prus.vntu@gmail.com

Keywords: software reliability optimization; logical-algorithmic model of the development process; multi-criteria variant analysis; fuzzy model of software reliability

Abstract. An approach to software reliability modeling and optimization based on the algebra of processes and fuzzy logic is proposed. The software development process is described using V.M. Hlushkov's algebra of algorithms. The sequence of events related to the introduction, detection and removal of errors is modeled using logical-algorithmic structures "work - control - correction", which correspond to the processes of development, testing and debugging. The logical-algorithmic model corresponds to the fuzzy knowledge base, which connects correctness levels of the working, testing and debugging stages with the decision classes interpreted as correct or incorrect execution of the task. To provide the best quality product within a limited time (cost), improving substitutions are embedded into the logical-algorithmic model. Improving substitutions aimed at selecting patterns of the development stages determine the structure and parameters of the software reliability model. Controllable variables associated with improving substitutions are interpreted as identifiers of implementation options of the development stages. Each variant is a logical algorithmic structure with controllable variables related to the quality of execution of the working, control and correction operations. Then the optimization problem arises, which is formulated in a direct and dual statement. It is necessary to find the implementation options, as well as controllable variables related to the quality of execution of logic-algorithmic structures, which ensure the constrained or extreme levels of software reliability and development time. A method of software reliability optimization based on multi-criteria analysis of variants is proposed. Software faultlessness criteria are considered as fuzzy sets defined on a universal set of variants using membership functions. For each stage, membership functions of fuzzy reliability estimates are constructed by means of a pairwise comparison of variants using the Saaty scale. Ranking of implementation options is carried out by intersecting fuzzy sets of criteria corresponding to the Bellman-Zadeh scheme. The ranks of the criteria which define the parameters of concentration of fuzzy sets correspond to the quality indicators of working, checking and correction operations. The synthesis of the logical-algorithmic model that ensures acceptable levels of software reliability and development time is carried out by selecting controllable variables associated with improving substitutions. The genetic algorithm is used to determine the structure of the reliability model by selecting the implementation options of the development stages. To ensure compliance with the requirements, the gradient method is used to adjust the parameters of the reliability model by selecting the ratios of repeated inspections and corrections.

Book of Abstracts: WORKSHOP on RECI 2024

Published by EDIS-Publishing House UNIZA,
Univerzitná HB, 010 26 Žilina in **November** 2025

First edition.

125 pages

ISBN XXX-XX-XXX-1918-3

www.edis.uniza.sk