

SUMMARY

The monograph *Automation of Discrete Processes: Theory and Applications*, edited by Andrzej Świerniak and Jolanta Krystek, provides a comprehensive overview of contemporary research in automation, artificial intelligence, robotics, operations research, optimization, and computational modeling. The heterogeneity of the issues under consideration is also linked to a broad interpretation of the concept of process automation, which – in addition to the synthesis and analysis of automatic control systems – encompasses the design and implementation of decision-making systems involving human participation. The volume consists of 43 chapters covering both theoretical foundations and practical applications of discrete process automation in engineering, logistics, manufacturing, information systems, and life sciences. The common theme linking all contributions is the use of formal models, computational methods, and intelligent algorithms for solving complex decision-making and optimization problems.

1. Artificial Intelligence, Machine Learning, and Data Analysis

The first thematic group includes chapters devoted to artificial intelligence, machine learning, computer vision, and data-driven decision support systems:

- Chapter 1: *Digital image vignetting correction with the use of a deformable radial polynomial model.*
- Chapter 4: *Automatic camera calibration for UAV-based vehicle speed estimation.*
- Chapter 5: *Video Data Anonymization for ADAS Systems.*
- Chapter 11: *Real-time fog detection method using image data: a preliminary study.*
- Chapter 19: *Aggregation of feature representations vs. voting of local decisions in collective object recognition.*
- Chapter 30: *Determination of order size in the enterprise using machine learning.*
- Chapter 31: *Analysis of the impact of data filtering on the performance of a model for identifying microRNAs with the greatest influence on transcriptome changes in cellular response to ionizing radiation.*
- Chapter 35: *Emotion recognition in social robotics: multimodal speech and text analysis in polish.*
- Chapter 36: *Product labeling and identification data compliance verification processes using artificial intelligence (ANN).*
- Chapter 39: *Analysis of the limitations of FCN_ResNet50 compared to transformer architectures in obstacle detection for trajectory planning.*

These contributions demonstrate the growing importance of machine learning and deep learning methods in automating perception and decision-making processes. The presented solutions address image enhancement, object detection, environmental monitoring, data privacy, speech and text analysis, and intelligent industrial applications. Several studies emphasize the significance of data quality, feature extraction, and model selection for achieving robust and reliable performance. The section also illustrates the transition from traditional rule-based systems toward adaptive and self-learning solutions capable of supporting real-time decision processes.

2. Robotics, Autonomous Systems, and Control

The second thematic area focuses on robotics, autonomous control systems, and human-machine interaction:

- Chapter 9: *Deep reinforcement learning vs. PID control: a comparison of autonomous navigation of a blimp in 3D environment.*
- Chapter 10: *Calibration of the steering axis of a 4-wheel drive platform – method and analysis of measurement data.*
- Chapter 13: *Mobile robot drive system configuration overview.*
- Chapter 28: *Synthesis of a hybrid control system and structural optimization of the MPER mobile exploration rover.*
- Chapter 32: *Detection of unfeasible pallet loading patterns for a robot.*
- Chapter 33: *Hybrid decision-making systems in social robotics: multilayer autonomy arbitration in shared-control architectures.*
- Chapter 39: *Analysis of the limitations of FCN_ResNet50 compared to transformer architectures in obstacle detection for trajectory planning.*

The authors investigate both hardware and software aspects of modern robotic systems. Particular attention is paid to autonomous navigation, control strategies, and intelligent decision-making under uncertainty. Several chapters compare classical control approaches with modern learning-based methods, highlighting the advantages and limitations of each. The works on social robotics extend the discussion beyond technical efficiency toward issues of trust, interaction quality, emotional awareness, and shared autonomy between humans and machines.

3. Optimization, Logistics, Energy Systems, and Manufacturing

The largest thematic group is devoted to optimization techniques and their applications in logistics, production systems, and energy management:

- Chapter 7: *Process externalities in automation projects: an illustrative analysis of order-picking automation.*
- Chapter 14: *Assessing time delays in data exchange between a simulation-based digital twin and industrial automation components.*
- Chapter 15: *The effect of non-discretionary inputs on crisis management efficiency assessment using data envelopment analysis.*

- Chapter 16: *Electrical energy consumption reduction in industrial compressed air systems using deep learning.*
- Chapter 20: *Optimal selection of intelligent services in a cloud application operational scenario.*
- Chapter 21: *An optimization model for energy flows in a distributed energy storage system without energy storage sharing.*
- Chapter 22: *Product allocation in an order-picking warehouse minimizing order-picking time under random demand.*
- Chapter 23: *Analysis of selected algorithms for scheduling jobs in a multi-machine flow shop production system.*
- Chapter 30: *Determination of order size in the enterprise using machine learning.*
- Chapter 41: *A linear programming framework for AI-based planning of seaport logistic operations under uncertainty.*
- Chapter 43: *Structural model of integrated enterprise process control systems.*

These chapters address a broad spectrum of optimization problems arising in modern enterprises. Topics include supply chain management, warehouse optimization, manufacturing scheduling, crisis management, digital twins, and industrial energy efficiency. The authors demonstrate how mathematical programming, simulation, machine learning, and decision-support tools contribute to higher operational performance and more sustainable resource utilization. Many studies are closely related to the Industry 4.0 paradigm, in which cyber-physical systems and data-driven analytics continuously improve production and logistics processes.

4. Discrete Systems Theory, Graph Theory, and Formal Models

Another important group of chapters develops the theoretical foundations of discrete process automation:

- Chapter 2: *On information size of combinatorial problems.*
- Chapter 12: *Benchmarks for one dimensional bin packing problem with conflicts.*
- Chapter 24: *On the problem of chromatic sum of a graph.*
- Chapter 34: *Levels of analysis of t -invariants in time Petri nets.*
- Chapter 37: *A static analysis of potential blocking and unblocking relations between t -invariants in Petri nets.*
- Chapter 40: *Optimization of a resilient backbone network topology under node failure conditions in unit disk graphs.*

These studies provide mathematical frameworks for representing, analyzing, and optimizing discrete dynamic systems. Significant attention is devoted to graph theory, combinatorial optimization, and Petri nets, which remain among the most important formalisms for modeling concurrent and distributed processes. Theoretical results presented in this section form the methodological basis for many practical applications discussed elsewhere in the monograph.

5. Computational Biology and Biomedical Applications

The final thematic group demonstrates the growing role of automation and discrete modeling techniques in life sciences and medicine:

- Chapter 17: *Sensitivity analysis of the cGAS–STING model with stochastic gene switching.*
- Chapter 18: *GaTher3DEvo — software for simulating spatial game theory models.*
- Chapter 26: *Monitoring the dynamics of SARS-COV-2 mutations using a discrete state machine.*
- Chapter 27: *Mathematical models of glycosylation—opportunities and challenges.*
- Chapter 29: *Finding the spatiotemporal treatment plan for fractionated radiotherapy using adjoint sensitivity analysis.*
- Chapter 31: *Analysis of the impact of data filtering on the performance of a model for identifying microRNAs with the greatest influence on transcriptome changes in cellular response to ionizing radiation.*
- Chapter 38: *Petri nets and methods for finding minimal precursor sets in CAR-T receptor signal domain design.*
- Chapter 42: *Graph-based detection of control structures in models of intracellular signalling pathways.*

The chapters illustrate how computational methods originally developed for engineering applications can successfully address biological and medical challenges. The presented research covers gene regulation, viral evolution, cellular signaling networks, treatment optimization, and immunotherapy design. By combining mathematical modeling, data analysis, and simulation techniques, these studies contribute to a deeper understanding of biological processes and support the development of more effective therapeutic strategies.

Concluding, the monograph presents a coherent and multidisciplinary perspective on the theory and applications of discrete process automation. The individual chapters can be organized into five major thematic areas: artificial intelligence and data analytics, robotics and autonomous systems, optimization and industrial applications, formal methods for discrete systems, and computational biology and medicine. Together, they demonstrate the growing integration of mathematical modeling, machine learning, optimization, and intelligent control within modern engineering and scientific practice. The volume convincingly shows that future advances in automation will increasingly rely on the synergy between formal methods, artificial intelligence, and real-world applications across industry, logistics, healthcare, and complex cyber-physical systems.