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Eunika Mercier-Laurent · Gülgün Kayakutlu ·  
Mieczyslaw Lech Owoc · Abdul Wahid ·  
Karl Mason  
Editors

# Artificial Intelligence for Knowledge Management, Energy and Sustainability


10th IFIP International Workshop on Artificial Intelligence  
for Knowledge Management, AI4KMES 2023  
Krakow, Poland, September 30 – October 1, 2023  
Revised Selected Papers

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ISSN 1868-4238 ISSN 1868-422X (electronic)  
IFIP Advances in Information and Communication Technology  
ISBN 978-3-031-61068-4 ISBN 978-3-031-61069-1 (eBook)  
<https://doi.org/10.1007/978-3-031-61069-1>

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# Preface

After the initial IFIP TC12.6 AI4KM workshop at ECAI (European Conference on Artificial Intelligence) 2012 held in Montpellier, France, in 2023 our workshop in extended form was back at ECAI 2023. Actually, it brought together in Krakow, Poland, the IFIP TC12.6 and TC12.11 working groups and our colleagues from the University of Galway working on AI for Sustainable Agriculture.

This common workshop was the second AI4KMES after those at IJCAI-21, Montréal, held online. The virtual conference, exposition and social events were amazing, however, they still lacked human exchanges, energy and serendipity.

Combining Knowledge Management, Energy and Sustainability leads to better understanding of the scope of each and of connections between the topics.

Sustainability covers many concerns often addressed separately. The answers of Chat GPT clearly demonstrate this separation. However, all elements influence each other and should be considered from various perspectives. The holistic approach to Knowledge Management provides a deeper understanding of the interconnections between the various domains and their interplay.

During these two days the participants improved their understanding of overall aspects of sustainability through various lenses and their connections with Climate Change.

Some information about the reviewing process:

We received 49 papers, of which 27 papers (10 long and 17 short) were accepted for presentation during these two days. The submitted papers were single-blindly reviewed; the acceptance rate is 55.1%. Number of reviews per paper: two or three in case of conflict. The invited speakers were selected to represent the current trends in the addressed fields and interest of the audience. They provided their abstracts, and their presentations are available on the workshop website.

The accepted papers covered a large scope of topics related to sustainability in various contexts such as smart cities, agriculture, energy and gas production and distribution, industry, management and biodiversity. The authors covered most of the 17 SD UN goals.

The three invited talks by Anne Nowé, Antoni Ligęza and Mieczyslaw Owoc emphasized the growing importance of multi-agent systems (MAS), the need for accurate explanations in neural network-based applications, and possible fake detection or insufficient understanding of sustainability and processing using knowledge-based AI approaches.

Anne Nowé did not find time to write a detailed paper, but she presented her work on the NRGcoin project <https://nrgcoin.org/> with emphasis on optimizing energy consumption with Multi-agent Systems, illustrated by control of windmills.

At the end of the second day the present PC members and organizers selected the best papers to be extended for this volume.

This selection focused on new contributions in any research area concerning the use of any AI field for Knowledge Management, Energy and Sustainability. An extended Program Committee then evaluated the last versions of the proposals, leading to this volume. The authors of 7 papers were asked for corrections and they made the corrections according to the reviewers' remarks.

The workshop opened with a tribute to Prof. Danielle Boulanger, who passed away last year. She was among the initiators of the AI4KM series and made a great contribution to the quality of these workshops and related publications.

Eunika Mercier-Laurent introduced the covered fields and their interconnections in the article entitled **“Artificial Intelligence, Sustainability and Climate Change”**.

Our first invited speaker Prof. Antoni Ligęza presented the ongoing and innovative research of his team in the area of eXplainable Artificial Intelligence. His paper titled **“In Search for Model-Driven eXplainable Artificial Intelligence”** reports on this research. A traditional XAI task is considered as finding an explanation of the model generated via Machine Learning by identifying the most influential variables for local decision-making. The proposed approach moves the explanatory process to the knowledge-level dimension. It is oriented towards Model Discovery, i.e. the internal structure and functions of the components.

The following article **“An intelligent chatbot based on hybrid approach implementing technical knowledge to support maintenance and training activities at Electricity of France (EDF)”** relates industrial experience in building a hybrid chatbot to assist technicians in installation and maintenance of an air conditioner in a nuclear plant. This chatbot elaborated by a team of engineers, designers, data scientists, technicians and academics mimics the human expert by combining “design shits”, data and experience.

The next paper entitled **“Supporting Food Computing with Ontologies and Artificial Intelligence Methods for Sustainability”** investigates the potential of combining food ontologies and AI in the food sector for enhanced sustainability. This combination can foster sustainable food systems, underscoring how semantic structures and AI can facilitate precision agriculture, sustainable food choices, personalized diets and climate change mitigation. The authors present an overview of food ontologies and knowledge graphs highlighting their structures and focal points, and illustrate the value of ontological reasoning through practical food domain examples, using SPARQL queries and ontological reasoning for insightful knowledge derivation. This article ends by a discussion on how to combine AI and ontologies to create new knowledge resources for improved data integration and management.

The authors of **“The use of semantic networks for the categorization of prosumers”** focus on sustainable business by creating a synergy buyer-seller. A consumer provides opinions, suggests solutions, and tests and evaluates the advantages and disadvantages of the product. This requires an identification of groups of consumers susceptible to cooperation with the organization. The authors experiment with the use of semantic networks for the categorization of consumers and defining the category of prosumers. The results presented in the article were obtained through the application of triangulation of research methods, such as analytical literature review, computer simulation conducted using Protégé software, and a research experiment consisting of simulation of selected problem situations.

The next paper entitled **“Methods for mitigating gender bias in binary classification models – a comparative analysis”** addresses the gender issues of UN SD goals 2 and 10. The growing importance of data requires verifications that the methods used to analyze it do not return unfair results. The purpose of this article is to identify gender bias in the selected dataset and compare which of the selected solutions gives the best result when used to mitigate the impact of this type of unfairness on the model’s predictions.

Generative AI influences the education process to the point that teachers have to reconsider their teaching methods. The authors of **“Chat GPT as a Learning Tool in Business Education. Re-search on Students’ Motivation”** studied the influence of Chat GPT as a learning tool in business education on the motivation of students and their learning experience. It can vary depending on implementation, context or individual student characteristics. They propose a diagnosis tool to evaluate the use of ChatGPT by Wrocław University of Economics students considering motivation, scope of questions/tasks, frequency of use, concerns and satisfaction. The related knowledge verification methods need also to evolve.

The next part of this book is devoted to the management of energy systems.

The first article in this part titled **“Integrating Artificial Intelligence into Electric Vehicle Energy Systems: A Survey”** discusses the contribution to planet protection and changes introduced by electric vehicles. Integrating electric vehicles into existing electricity grids, refuelling stations and supply chains presents significant challenges that can be effectively addressed through the implementation of artificial intelligence solutions. After investigation of the challenges associated with the widespread adoption of electric vehicles in society the authors analyse in detail how artificial intelligence can facilitate the smooth integration of electric vehicles. The paper provides also a detailed investigation of the life-cycle emissions of electric vehicles and examines the limitations of existing research in this area and suggests potential avenues for future research.

The following article **“Towards sustainable power systems: exploring the opportunities of multi-task learning for battery degradation forecasting”** focuses on the battery for electric vehicles.

The task of developing a reliable and long-lasting battery system remains a major obstacle to the expansion of the electric vehicle fleet and the improvement of storage systems in renewable energy plants. To overcome this challenge, improving battery ageing models to accurately forecast the battery degradation trajectory is a complex but critical step. The authors propose to address these challenges using a sequence-to-sequence multi-task learning (MTL) method. Empirical results on battery ageing datasets show that the proposed model enhances the data efficiency and precision of capacity and power degradation forecasts for lithium-ion battery cells. Furthermore, it generates new insights into the trade-offs and key decisions for incorporating battery ageing models into the MTL paradigm.

The next article titled **“The Influence of Neural Networks on Hydropower Plant Management in Agriculture: Addressing Challenges and Exploring Untapped Opportunities”** points out the importance of stable renewable energy and water management for sustainable agriculture, especially in drought areas.

A key concern is the potential conflict between electricity generation and agricultural water needs. Prioritizing water for electricity generation can reduce irrigation

availability in agriculture during crucial periods like droughts, impacting crop yields and regional food security. Coordination between electricity and agricultural water allocation is necessary to ensure optimal and environmentally sound practices. This work is a call for attention and highlights the potential risks of deploying neural network-based hydropower plant management software without proper scrutiny and control. To address these concerns, the authors propose the adoption of the Agriculture Conscious Hydropower Plant Management framework, aiming to maximise electricity production while prioritizing stable irrigation for agriculture. They also suggest a set of regulatory measures to promote model transparency and robustness, certifying software that makes conscious and intelligent water allocation decisions.

The authors of **“Classification Tree Based AI System for Short Term Prediction for Heat and Power Plants”** note that companies supplying electrical energy rely mainly on long-term agreements with electricity producers. In reality, the daily demand should be precisely predicted for 48 hours considering current weather conditions. A similar analysis applies also for heat and power plants, but the temperature of returning water is most important. Time series models can be used for forecasting. The authors propose to build an AI system to choose the future profile from historical data with time series of 24 hours. Then, these empirical profiles are clustered with hierarchic and non-hierarchic clustering procedures to form homogeneous groups (types of profiles). Finally, the classification methods are applied using weather data and observed demand from previous days (up to one week backwards). The authors propose a measure for the forecasting evaluation.

The article by our invited speaker Mieczyslaw Owoc fits perfectly into the next part devoted to some sustainability aspects.

His paper on **“Usability of Honeybee Algorithms in Practice. Towards Nature-inspired Sustainable Development”**, inspired also by his beekeeping activities, describes the usefulness of Honeybee algorithms (HBAs) for complex problem solving with the focus on optimization and practical usability of these algorithms, exploring their strengths and limitations in real-world applications, particularly within the context of sustainable development. HBAs demonstrate impressive performance in finding optimal solutions, particularly for large-scale and dynamic problems, adaptability (their decentralized nature allows them to handle changes in the environment effectively) and sustainability (they often require fewer resources compared to traditional optimization methods, contributing to a more sustainable approach). Prof. Owoc presents some examples of resource optimization in energy usage in buildings, transportation networks and industrial processes, and in efficient waste management and optimized renewable energy integration.

The next article is **“Automatic Coral Morphotypes Detection with YOLO: A Deep Learning Approach for Efficient and Accurate Coral Reef Monitoring”**.

The protection and preservation of marine biodiversity includes the care of coral reefs, which are declining rapidly mostly as a consequence of human activity. Conservation efforts rely on monitoring of coral abundance and composition as predominant indicators of ecosystem health and management success. While manual monitoring of coral abundance is not trivial, artificial intelligence-based automatization can help to improve efficiency and accuracy. The authors experiment with a methodology using YOLOv5-based deep learning for automatic detection of corals and



classification by morphotype, representing an important step toward streamlining machine-assisted coral reef monitoring.

The authors of **“Answering Key Questions about Air Pollution Dynamics in Ho Chi Minh City: A Spatiotemporal Analysis Using the XAI-SHAP Clustering Approach”** focus on fresh air preservation in big cities. Their study investigates the impact of various air pollutants in Ho Chi Minh City (HCMC), Vietnam, employing a supervised clustering approach that integrates Shapley Additive exPlanations (SHAP) values with a publicly available outdoor air quality dataset. The research focuses on identifying influential pollutant factors, affected city regions, their impact on surrounding areas, and the effectiveness of supervised clustering using SHAP values in pinpointing intersections between impacted stations. Key findings indicate a pronounced influence of Nitrogen Dioxide (NO<sub>2</sub>) and Temperature on morning air quality, largely attributed to traffic congestion. Conversely, Carbon Monoxide (CO) and Ozone (O<sub>3</sub>) significantly affect the afternoon air quality, influenced by solar radiation and industrial activities.

The authors of the article titled **“Crowdsourcing as a tool for Smart City within Sustainable Development”** study innovations in management methods for effective urban resources management. The Smart City (SC) concept, increasingly adopted in various global metropolises, significantly enhances residents’ quality of life, safety, social participation, and operational efficiency of urban areas, aligning with the crucial paradigm of Sustainable Development (SD). A key initiative underpinning the SC model is crowdsourcing, a method whereby urban administrations gather knowledge and feedback from their citizens.

This paper presents findings from an examination of scientific literature indexed in the Scopus database, using keywords: ‘crowdsourcing’, ‘smart cities’, and ‘sustainable development’. Employing Classical Literature Review (CLR) and Systematic Literature Review (SLR) methodologies, supplemented by bibliometric analysis with VOSviewer software, this study conducts an in-depth investigation of keywords and research themes closely linked to the development of crowdsourcing within the SC framework, specifically in the context of SD.

The next article is devoted to the **“Model of Relationship between Circular Economy and Industry 5.0”**. The author studies the interactions between Industry 5.0 and Circular Economy in the European Union countries. The primary goal of this research is to develop an econometric model demonstrating the impact of CE activities on the advancement toward Industry 5.0. The integration of Sustainable Development (SD) principles across various sectors of industry is also considered. To conduct this research the author uses the selected indicators and data from Eurostat, analyzed using taxonomic method and a regression algorithm.

Information technology (IT) generates also a huge amount of CO<sub>2</sub> and waste. While we can find some works on carbon emission by software, the authors of **“Reduction of carbon dioxide emissions of IT hardware”** focus on hardware, vital for running the software. The greening of hardware is also mandatory for achieving sustainable and environmentally friendly technological advancements. The authors study factors such as hardware infrastructure, energy consumption and the carbon footprint of data centers and communication networks. They study the various strategies and technologies that have been developed to reduce CO<sub>2</sub> emissions during computations. These include

energy efficient designs, advanced cooling techniques, renewable energy integration, audits and controls, and optimization algorithms such as modern AI tools. The advantages and limitations of each approach are discussed, with a focus on their potential for widespread adoption and scalability. The authors point out the need for continuous research and innovation to overcome existing barriers and accelerate the adoption of environmentally friendly hardware systems on a global scale.

We would like to thank the members of the Program Committee for reviewing the submitted papers and helping put together an interesting program. We would also like to thank all authors and our invited speakers Ann Nowé, Antoni Ligęza and Mieczyslaw Owoc for their inspiring presentations.

Finally, our thanks go to the local Organizing Committee and all the supporting institutions and organizations.

We hope that you enjoy reading these papers.

March 2024

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