



Technologies of the 4th industrial revolution with applications

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The technologies of the 4th industrial revolution (IR), like artificial intelligence (AI) and automation, have introduced a new era in our post-modern societies. A major portion of our daily professional activities have been augmented. Productivity has been increased, on the one hand, but our lives have become much more complicated on the other. Our world has changed dramatically, and it keeps changing as new technologies and algorithms are continuously emerging, whereas existing ones keep evolving. The spectrum of the application domains is becoming wider everyday offering new trends and solutions, but it is not all rosy for us, as new challenges have been introduced.

This is the Editorial of the “Technologies of the 4th Industrial Revolution with applications” Special Issue (SI) of the NCA scientific journal that tries to shed light on AI-related technological advances and their applications. All research papers published in this SI have a high level of novelty as they contribute both in theoretical and in application level.

Overall, nineteen original research papers have been submitted for potential publication in this SI. All papers have passed through a peer review process by at least two independent academic reviewers, and fifteen of them were finally accepted.

The first paper is authored by Jiangjiang Zhang et al., and it is offering an effective security model to 4th IR processes. The authors of this paper are introducing an intelligent novel edge trusted decision mechanism for

distributed Internet of things. This model includes static, dynamic, and comprehensive trusted decision components (TDC). A particle swarm optimization algorithm is introduced to adaptively adjust the weighting factors of static and dynamic TDC, and the comprehensive trusted decision is calculated. The results have proved that the introduced approach can timely and accurately detect malicious devices.

A trusted authentication scheme based on a super SIM card for an Industry 4.0 mobile office scenario is presented in the paper authored by Lingnan Kong et al. The authentication between the terminal device and the operator is realized based on the generic bootstrapping architecture authentication technology, of the super SIM card. The paper includes a comprehensive security analysis and proof that the scheme satisfies two-way authentication, anti-replay attack, anti-forgery attack, anti-man-in-the-middle attack and non-repudiation.

Manos Kirtas et al. are proposing a mixed-precision quantization-aware training for photonic neural networks. More specifically, they introduce a quantization-aware training approach that gradually performs bit reduction to layers in a mixed precision manner. They follow lower precision networks during deployment, and they further increase the computational rate of the developed accelerators while keeping the energy consumption low. It is about gradually reducing layers’ bit resolutions, by normally distributing the reduction probability of each layer.

Alexander Scherrer et al. have authored a paper on a hybrid AI approach to oncologic follow-up care for cancer patients which provides aid toward overcoming the after-effects of therapy. The system interacts with the patients via a mobile application in order to produce proper recommendations.

The fifth paper is authored by Domenico Amato et al., and it has basic elements of novelty. It presents a model that employs neural networks as building blocks for the design of efficient learned indices. This novel paper considers learned data structures which consist of a mixture of machine learning techniques with those specific to Data Structures. The authors introduce the adoption of neural

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networks as the fundamental units of classic data structures which is the case of learned Bloom filters. The purpose is to achieve time/space gains and to improve the overall performance.

The sixth paper is authored by George Manias et al. The authors perform a comparative analysis of multilingual approaches, in an effort to classify both the sentiment and the text of an examined multilingual corpus. More specifically, four multilingual BERT (bidirectional encoder representations from Transformers)-based classifiers plus a zero-shot classification model are introduced. Their accuracies and their applicability in the classification of multilingual data are presented and compared.

As part of Industry 4.0, sentiment analysis can be used to study public attitude toward future pandemics and sociopolitical situations in general. This research by Panagiotis Theocharopoulos et al. presents an analysis framework by applying a combination of natural language processing techniques and machine learning algorithms to classify the sentiment of tweets as positive or negative. This is achieved by applying a combination of natural language processing techniques and machine learning algorithms.

Vasileios Kochliaridis et al. are introducing a deep reinforcement learning model with technical analysis and trend monitoring, on cryptocurrency markets. The introduced approach has been employed on 5 popular cryptocurrencies, and the results show that the integration of these three methods offers a very reliable and robust model.

The ninth paper is authored by Peter Hajek and Michal Munk. The authors suggest that text sentiment analysis and speech emotion recognition play an important role in finance due to their potential to capture the intentions and opinions of corporate stakeholders, such as managers and investors. They are proposing a deep learning architecture that uniquely combines the managerial emotional states that were extracted using the FinBERT-based sentiment analysis.

Charalampos M. Liapis et al. investigate the use of ensemble learners for medium-term forecasting of the Greek energy system load, using additional information from injected energy production by various sources. Over 435 regression schemes and 64 different modifications of the feature inputs were tested over five different prediction time frames. Finally, they are proposing an ensemble method that incorporates the orthogonal matching pursuit together with the Huber regressor according to an averaged combinatorial scheme.

The eleventh paper is authored by Wei Zheng et al. It presents a secure sharing of industrial Internet of things (IoT) data, based on distributed trust management and trusted execution environments for IoT devices. The whole

approach follows a federated learning architecture which is a distributed machine learning paradigm with privacy preserving properties. The result is a feasible secure data circulation and sharing scheme.

The twelfth paper is authored by Georgios Vardakas and Aristidis Likas. The authors introduce a clustering approach based on generative neural networks, called neural implicit maximum likelihood clustering. This hybrid algorithm adopts both ClusterGAN (clustering generative adversarial networks) and implicit likelihood maximization (IMLE ClusterGAN). The aim is to overcome some deficiencies of ClusterGANs, such as mode collapse, vanishing gradients and training instability. This is a very interesting research with certain level of novelty.

Bingquan Wang and Xue Liao have authored an interesting research paper on a trusted routing mechanism for multi-attribute chain energy optimization, for industrial Internet of things (IIoT). The problem under examination is the fact that the heterogeneity of Industrial equipment, the limitation of resources and the low security of data have greatly hindered the development of IIoT. Therefore, the authors are introducing a trusted relay routing mechanism for optimizing chain performance, based on multi-attribute comprehensive evaluation for the IIoT, in order to ensure efficient energy utilization.

The 14th paper is authored by Athanasios Kallipolitis et al., and it is a very interesting research on image processing enhancement for biomedical modeling. The authors are trying to further improve the performance of the gradient-weighted class activation mapping technique and the generated visualizations. Thus, they propose a segmentation-based explainability scheme that focuses in the common visual characteristics of each segment in an image, to provide enhanced visualizations instead of highlighting rectangular regions. The explainability performance was quantified by applying random noise perturbations on microscopy images.

The last 15th paper is authored by Saeed Seraj et al., and it describes the MVDroid which is an approach detecting malicious attacks on Android users, who are installing any virtual private networks (VPN). The detection is done before the VPN installation by using deep neural networks.

We wish to express our deep appreciation and gratitude to the Editor in Chief of the NCA journal, Professor John Macintyre, for offering us the chance to edit this timely issue that contributes to the scientific community fifteen high quality research papers on the hot area of AI and the 4th IR. We do believe that they will be appreciated by the international scientific community and that they will become a source of inspiration for further research.

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