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Editorial

Special Issue on "Machine-Learning-Assisted Intelligent Processing and Optimization of Complex Systems"

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1. Introduction

Complex systems and their various characteristics have been widely considered in economic and industrial systems. With the growth of studies in the field of artificial intelligence (AI), traditional methods that relied on prior knowledge and experiences cannot satisfy the accuracy and speed requirements of current complex systems in diversified environments.

Due to the increasing popularity of big data and AI technologies, these have become crucial types of monitoring data in fields such as finance, industry, and medicine. People can predict future trends, monitor irregularities, and categorize collected data by analyzing raw data from complex networks. For instance, according to Corceiro et al. [1], new developments have been studied in deep learning models and approaches to identify and categorize weeds, in order to enhance crops' sustainability. Although many complex systems cannot be directly observed, their internal relations and optimization can be constructed by analyzing the relevant data, which is crucial for controlling the corresponding complex systems. Thus, the processing and optimization of complex systems from big data has become a prominent and challenging issue.

Learning is the most fundamental property of any intelligent system, and machine learning (ML) is emerging as one of the most profound research areas in AI, which focuses on acquiring, transferring, regenerating, and utilizing potential information from complex systems. However, ML faces challenges when analyzing systems with strong uncertainty, randomness, redundancy, or imperfect characteristic information. In this context, Alves et al. [2] underline that human centricity should strengthen human beings and industrial operators to enhance their proficiencies and merits in collaborating or cooperating with digital devices. Focusing on ML as the critical problem in processing and optimization, this dissertation systematically discusses important and unsolved topics, including intelligent processing, system identification and optimization, malware detection and classification, intelligent modeling algorithms, etc.

Considering the data-driven capabilities and assisted-intelligent processing for complex systems, ML could revolutionize various applications and industries, which is crucial in AI-driven systems. The ultimate objective of such assistance is to execute an environmentally friendly procedure, prosperously yielding economic and health benefits.

The current Special Issue on "Machine-Learning-Assisted Intelligent Processing and Optimization for Complex Systems" (https://www.mdpi.com/journal/processes/special_issues/Machine_Learning_Intelligent, accessed on 20 May 2023) compiles new research by prominent scholars in the fields of modeling, ML, intelligent processing, and optimization of some relevant complex systems. Therefore, it provides innovative and illustrative examples, potential applications, and possible solutions to enhance the mentioned systems.

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2. Intelligent Processing of Complex System

Some articles utilize ML approaches to solve practical problems from complex systems. Yin et al. [3] proposed a novel framework to effectively extract industrial safety knowledge, which summarizes the knowledge concept entities of machine and model description languages by combining the asset management shell. Dai et al. [4] presented a task-offloading and resource-allocating technique in multidomain cooperation (TARMC) for the industrial Internet of Things (IIoT) in response to the non-uniform distribution of task allocation between different cluster domain networks and the stability of conventional industrial wireless network architecture. The results indicate the superior performance of the Gaussian process technique, due to its lower error bandwidth.

In order to locate the source of gas leaks in several engineering areas, Ishigami et al. [5] investigated the practical applicability of adopting a convolutional neural network (CNN) to predict the location of gas leaks based on captured infrared images. The study found that a single learner trained with a sufficient number of images achieved an inference precision higher than 85%. Considering the problem of fault diagnosis accuracy, Liu et al. [6] integrated adaptive multi-threshold segmentation with a subdomain adaptation to propose a deep transfer fault diagnosis technique, exhibiting a higher diagnostic accuracy than and superiority to other diagnostic methods. ML methods were proposed to assess flexural strength by Li et al. [7]. Compared to other methods, the results illustrated the lower error bandwidth of the Gaussian process technique, which results in superior performance.

The striped rice stem borer (SRSB), *Chilo suppressalis*, has significantly alleviated the yield and quality of rice in China. Proper and precise forecasting of the rice pest population may assist in determining a pest control approach. Tan et al. [8] utilized weather parameters and time series of relevant pests to apply multiple linear regression (MLR), gradient boosting decision tree (GBDT), and deep auto-regressive (DeepAR) models to dynamically predict the SRSB population incidence within the crop season from 2000 to 2020 in the Hunan Province, China, and the results can achieve the most accurate dynamic forecasting.

3. Controlling of Complex Systems

Additionally, another article demonstrates the combination of ML methods and control strategies from the perspective of intelligent control. Hydraulic fracturing is crucial to improve oil and gas production. Nevertheless, traditional approaches cannot directly control the nozzle diameter, leading to 'sand production' in the flowback fluid, thus influencing the hydraulic fracturing application. The nozzle should be appropriately adjusted to prevent 'sand production' in the flowback fluid. A new augmented residual deep learning (DL) neural network (AU-RES) was presented by Sharma et al. [9] in order to detect the features of multiple one-dimensional time series signals and efficiently forecast the nozzle diameter.

4. Optimization of Complex Systems

Many studies verify particular processes to enhance the efficiency of particular models by extracting more information from specific environments. With the growth of Internet cloud technology, the data scale is extending. Conventional processing approaches cannot solve the problem of data extraction from big data. Thus, ML-assisted intelligent processing should be employed for extracting data to solve optimization problems in complex systems. The relevant works will be presented in the following.

Hong et al. [10] presented the discrete artificial bee colony cache strategy of UENs (DABCCSU). The simulations indicated that the precision of DABCCSU in content popularity forecasting exceeded 90%, attaining an excellent forecasting impact. Text data is essential data that immediately describes semantic data. Therefore, Yang et al. [11] demonstrated that topic-modeling- and transfer-learning-based text vectorization (TTTV) obtain superior outcomes when computing the similarity of texts with a similar topic, indicating

that it can more precisely distinguish whether the two particular texts' contents belong to a similar topic.

The drop effect on a dry substrate can be observed in natural and industrial processes. In contrast to the conventional method through scaling rules and analytical models, Tembely et al. [12] proposed a data-driven technique to estimate the maximum spreading parameter via supervised ML approaches. This research facilitates the establishment of a general model to adjust the droplet effect, which can optimize various industrial systems.

Moreover, one article deals with the relationship between COVID-19 risk and the rate of wearing masks in public places. The prevalence of COVID-19 worldwide has resulted in a universal safety disaster associated with economic outcomes. As per the World Health Organization (WHO), the mentioned destructive crisis can be alleviated by utilizing facemasks in public locations. Nevertheless, COVID-19 can be prevented only by proper nose and mouth coverage. An automatic mask-wearing system is required for these situations, in accordance with the work of Waziry et al. [13], whose experimental work indicated the superiority of InceptionV3 and EfficientNetB2 to other approaches, achieving a total precision of about 98.40%.

Regarding the economic effects of complex systems with ML assistance, optimization approaches have been utilized to enhance production flows, cold storage management, and fruit center distribution. Proença et al. [14] optimized the production rules and management logistics to improve productivity, energy efficiency, human resources distribution, and food quality, while alleviating food waste.

5. Conclusions

We believe that the articles in this Special Issue reveal several advantages in intelligent processing and optimization for complex systems based on ML assistance. Expertise in ML, as well as numerical analysis and applications of complex networks, should be demanded for in pursuing research in this field. We hope that this issue promotes integration among different communities, as artificial intelligence becomes increasingly indispensable.

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References

1. Corceiro, A.; Alibabaei, K.; Assunção, E.; Gaspar, P.D.; Pereira, N. Methods for Detecting and Classifying Weeds, Diseases and Fruits Using AI to Improve the Sustainability of Agricultural Crops: A Review. *Processes* **2023**, *11*, 1263. [CrossRef]
2. Alves, J.; Lima, T.M.; Gaspar, P.D. Is Industry 5.0 a Human-Centred Approach? A Systematic Review. *Processes* **2023**, *11*, 193. [CrossRef]
3. Yin, Z.; Shi, L.; Yuan, Y.; Tan, X.; Xu, S. A study on a knowledge graph construction method of safety reports for process industries. *Processes* **2023**, *11*, 146. [CrossRef]
4. Dai, Z.; Zhou, Y.; Tian, H.; Ma, N. Task-Offloading and Resource Allocation Strategy in Multidomain Cooperation for IIoT. *Processes* **2023**, *11*, 132. [CrossRef]
5. Ishigami, T.; Irikura, M.; Tsukahara, T. Applicability of Convolutional Neural Network for Estimation of Turbulent Diffusion Distance from Source Point. *Processes* **2022**, *10*, 2545. [CrossRef]
6. Liu, Y.; Kang, J.; Wen, L.; Bai, Y.; Guo, C.; Yu, W. Fault diagnosis algorithm of gearboxes based on GWO-SCE adaptive multi-threshold segmentation and subdomain adaptation. *Processes* **2023**, *11*, 556. [CrossRef]
7. Li, R.; Wei, H.; Wang, J.; Li, B.; Zheng, X.; Bai, W. An Artificial Intelligence Method for Flowback Control of Hydraulic Fracturing Fluid in Oil and Gas Wells. *Processes* **2023**, *11*, 1773. [CrossRef]
8. Tan, S.; Liang, Y.; Zheng, R.; Yuan, H.; Zhang, Z.; Long, C. Dynamic Prediction of *Chilo suppressalis* Occurrence in Rice Based on Deep Learning. *Processes* **2021**, *9*, 2166. [CrossRef]
9. Sharma, N.; Thakur, M.S.; Malik, M.A.; Alahmadi, A.A.; Alwetaishi, M.; Alzaed, A.N. Assessing Waste Marble Powder Impact on Concrete Flexural Strength Using Gaussian Process, SVM, and ANFIS. *Processes* **2022**, *10*, 2745. [CrossRef]

10. Hong, Y.; Zhang, Y.; Fan, S. Research on Discrete Artificial Bee Colony Cache Strategy of UAV Edge Network. *Processes* **2022**, *10*, 1838. [CrossRef]
11. Yang, X.; Yang, K.; Cui, T.; Chen, M.; He, L. A Study of Text Vectorization Method Combining Topic Model and Transfer Learning. *Processes* **2022**, *10*, 350. [CrossRef]
12. Tembely, M.; Vadillo, D.C.; Dolatabadi, A.; Soucemarianadin, A. A Machine Learning Approach for Predicting the Maximum Spreading Factor of Droplets upon Impact on Surfaces with Various Wettabilities. *Processes* **2022**, *10*, 1141. [CrossRef]
13. Waziry, S.; Wardak, A.B.; Rasheed, J.; Shubair, M.; Yahyaoui, A. Intelligent Facemask Coverage Detector in a World of Chaos. *Processes* **2022**, *10*, 1710. [CrossRef]
14. Proença, A.P.; Gaspar, P.D.; Lima, T.M. Lean Optimization Techniques for Improvement of Production Flows and Logistics Management: The Case Study of a Fruits Distribution Center. *Processes* **2022**, *10*, 1384. [CrossRef]