Society 4.0: issues, challenges, approaches, and enabling technologies

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EDITORIAL

This guest edition of Cybernetics and Systems is a broadening continuation of our last year edition titled “Intelligence Augmentation and Amplification: Approaches, Tools, and Case Studies” [1]. This time we cover research perspective extending towards what is known as Society 4.0. Bob de Vit brought the concept of Society 4.0 to life in his book “Society 4.0 – resolving eight key issues to build a citizens society” [2]. From the Systems Science point of view, one of this concept’s enabling technologies mechanisms would be Semantic Web [3] driven by Artificial Intelligence, Augmented Intelligence, Digital Twin, Platform Economies, Internet of

Things, Smart Social Networks, Machine Learning/Deep Learning, and Cyber Physical Systems. With the help and progress in these research themes and technologies, business, commerce, production etc. would become increasingly smarter, and machines talking to machines would handle most of our daily activities, including decision-making, sustainability, wellbeing, and security. The aim of this Guest Edition of *Cybernetics and Systems* is to address some aspects in this global transformation path of our society.

The selection of research contributions to this issue opens with the paper titled "*Intelligent Collectives: Impact of Independence on Collective Performance*". Collective intelligence has been recently applied to solve a wide range of complex problems. The underlying mechanism behind this notion is the proposition that a group of individuals as a whole can display abilities not shown by individuals. In this paper, the Authors investigate the impact of independence on collective performance by taking into account individual reputations and graph theory. The proposed approach is useful in a number of semantic web related issues, like ontology integration, user interfaces development, and smart multi-agent systems.

The authors of the following paper titled "*ViT-TB: Ensemble learning based ViT model for tuberculosis recognition*" enter into the increasingly important machine learning support in the area of medical diagnosis. They propose a collective deep learning strategy for TB detection using Montgomery and Shenzhen datasets, which makes use of several preprocessing and data augmentation techniques. The proposed approach employs a wide variety of deep learning versions, image enhancement techniques, and pre-trained deep learning models. The experiments presented in the paper show that the proposed model yielded substantially more accurate results than the state-of-the-art approaches.

The paper that follows is titled "*A centralization measure for social networks assessment*" and it represents another collective intelligence related research in this special issue. The Authors

propose in this paper a novel measure for assessing graph centralization that may be utilized by variety collective models. The conception presented in the paper was verified by extensive and well-conceptualised experimentation showing its superiority over the current state-of-the art measures.

In the following paper titled "*Smart Karyotyping Image Selection based on Commonsense Knowledge Reasoning"* the authors contribute to the complex process of chromosome classification by introducing a novel smart karyotyping image selection technique. The proposed method evaluates metaphase images based on inference with commonsense knowledge represented as functional modules. Unlike similarity-based methods, the presented method can assess images according to the object-object relations in images' content rather than calculating the images' overall similarities. The initial experiment shows that this new method can correctly evaluate the metaphase images and thus enhace the karyotyping process that follows.

The next paper is titled "*A method for information security analysis using information graphs"* The paper introduces the concept of information graphs and proposes its use in information flow security enhancement. For this purpose, the Authors introduce a specialised information graph called the Potential Security Conflict Graph and present its applicability in reducing vulnerabilities in organisational information flow structures.

The following paper is titled "*Mining association rules from a single large graph"*. In this paper, the Authors surveyed the graph-based association rules mining existing algorithms and proposed a new efficient one-phase association rule-mining algorithm. In their proposed approach, the Authors applied the one-phase model, which significantly improved the overall performance of the association rules mining from graph datasets. Several experiments on the

proposed algorithm are presented in the paper showing that it significantly outperforms the current approaches at all tested τ thresholds and on all tested datasets.

The next paper is titled *"KEMR-Net: A Knowledge-Enhanced Mask Refinement Network for Chromosome Instance Segmentation"*. It addresses in a novel way one of the biggest challenges of karyotype analysis – chromosome segmentation. This paper proposes KEMR-Net, a knowledge-enhanced mask refinement network that uses a cascaded network to produce high-quality chromosome detections and initial instance masks. Then the masks are optimised with the knowledge contained by the Neural Knowledge DNA knowledge representation. The presented approach is shown to outperform the current baseline methods.

The paper that follows is titled *"Decisional-DNA-based Digital Twin implementation architecture for Virtual Engineering Objects"*. Digital twin refers to a digital replica of potential and actual physical assets (physical twin), processes, people, places, systems and devices that can be used for various purposes. In this paper the Authors proposes a general DT implementation architecture for engineering objects/artifacts used in conventional manufacturing. It will empower manufacturers to leverage DT for real-time decision-making, control, and prediction for efficient production. An application scenario of Decisional-DNA based anomaly detection for conventional manufacturing tools is demonstrated as a case study to explain the architecture.

This Special Issue is concluded with a brief communication of an interesting concept of a knowledge engine for reasoning-based human chromosome classification. The paper is titled "*Towards Human Chromosome Knowledge Engine* " and it proposes that the engine stores knowledge of chromosomes via a novel representation structure, the Chromosome Part Description (CPD), and reasons over CPDs by utilizing the probability tree model (PTM) for classification process. This is an exciting, new way of looking into genetic information about our life. Initial experimentation results with the proposed engine are very promising.

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