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Preface for the Special Issue of International Congress on Engineering and Complex Systems ICECS'23—Intelligence in complexity: Intersection of Machine Learning and Complex Systems

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Abstract The main contributions of [Stat. Optim. Inf. Comput. Vol.12 , No. 3 (2024)], consisting of seventeen papers selected and revised from the International Congress on Engineering and Complex Systems ICECS'2023, are highlighted.

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Contemporary science and engineering find itself at the heart of a constantly evolving landscape, where the complexity of systems challenges not only our understanding but our ability to conceive, develop, and maintain effective solutions as well. Complex systems, intersecting multiple interdependent variables, represent an exciting and stimulating challenge for researchers today.

In this special issue dedicated to exploring complex systems and their impact on different field, we delve into a domain where apparent simplicity often conceals subtle interactions and unpredictable dynamics. Complex systems, whether of natural or human-made origin, encompass interconnected networks, feedback loops, and emergent behaviors, giving rise to a myriad of intellectual and practical challenges.

Complex systems transcend traditional disciplinary boundaries, requiring a holistic and integrated approach. Researchers are called to rethink their methodologies and adopt a systemic mindset to confront the dynamic and interconnected reality of contemporary challenges. Through a series of case studies and in-depth analyses, this special issue presents recent theoretical and experimental studies that address complex systems in the following fields: Healthcare, image reconstruction, energy, robotics and finance.

Machine Learning (ML) plays a significant role in healthcare, offering transformative potential in various aspects of the industry from diagnosis and medical image processing to personalized medicine and predictive analytics. AHOURAG et al. presented in their paper a new model based on a multi-objective practical swarm algorithm to generate the diets that ensure an ideal compromise between the total cost and total glycemic load. These diets are well-balanced and meet each patient specific requirements. The proposed solution was tested in the case of Moroccan patients. AIT BRAHIM et al. proposed a new pipeline that predict the ideal therapeutic protocol and the number of treatment cancer adequate to a particular patient with breast cancer. The proposed pipeline includes data augmentation and splitting step as well as a Random Forest based model to classify the protocols. The authors conducted their validation tests on real dataset constructed in collaboration of the University Hospital Center of Marrakesh, Morocco and compared the results of large number of state of art ML approaches.

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Image segmentation in healthcare isolates and identifies specific structures or regions of interest within an ct-scans and MRI in the aim to assess the decision making process. ELKARI et al. proposed a novel multi-Datasets CNN (MD-CNN) architecture specifically tailored to effectively handle combined data comprising diverse image characteristics across multiple datasets to address glaucoma prediction across. ElMOURABIT et al. explored the use of generative models to deal with the lack of annotated data in medical image segmentation. Indeed, segmentation models should be trained on balanced annotated data that need experts. Authors performed a self-supervised process to detect COVID-19 lesions in Lung CT-scans. This process is based at first on a Generative Adversial Network that generates synthetic data to create lesions masks. These masks are used in a Unet architecture to perfom segmentation and anomaly detection.

Image processing technics are the key enable of the resolution of various complex problems. NAOUADIR et al. leveraged in their work the low variability characteristic of astronomical images to detect celestial objects. They computed the mean squared error for the reconstructed astronomical image, derived from its Jacobi moments. These moments are calculated multiple times focusing on different regions within the image. The parameters used to compute Jacobi moments to focus on that region are then interpreted as the coordinates of celestial objects. AAKAM et al. provided an enhanced and effective Krawtchouk moments parameter p optimization approach using the Artificial Bee Colony (ABC) algorithm optimization technique for the purpose of completing tasks including the reconstruction and classification of 3D and 2D images with high quality. The orthogonal moments giving relevant results these last years within the framework of object detection, pattern recognition and image reconstruction, SAHMOUDI et al. presented an approach based on orthogonal functions called " Orthogonal Jacobi Polynomials (OJPs)". They introduced a new set of moments called Generalized Jacobi-Fourier Moments (GJFMs) to reconstruct images. MOUSSAOUI et al. presented a technique for detecting and recognizing Arabic and Latin license plates. After assembling the gathered images to create a novel dataset, they utilized YOLO v7 to locate and identify the number plate in the image and kernel methods as well as thresholding to get rid of the extra vertical lines on the plate. After that, they employed Arabic OCR along with Easy OCR methods to decipher the Latin and Arabic characters on the number plate. MANSOURI et al. proposed a novel hybrid security system for encrypted color images using a DNA computing model, chaotic systems, and hash functions as a basis. The proposed hybrid system includes DNA permutation and diffusion.

The interaction between complex systems and the energy sector is multifaceted, as the production, distribution, and consumption of energy involve intricate and interconnected processes. Branching structures are gaining popularity in the field of advanced structures and building design. They offer high performance in terms of strength and lightweight design, along with the flexibility and precision enabled by modern processing technologies. RIHANI et al. provided a concise overview of a geometric design procedure for a novel ribbed class of structures developed as a biomimetic optimal Micro-architected dome. Hereinafter, linear lattice models were suggested to carry out structural calculations using the finite element method (FEM). KADDOURI et al. presented an energy efficiency study for a residential building located in the city of Al-Hoceima, Morocco. The aim is to bring the building into compliance with the technical requirements of the Moroccan Thermal Building Regulations (RTCM). To achieve this, a number of modifications and interventions were carried out, such as the use of hemp concrete for insulation and the integration of passive strategies to minimize energy loads. AGROUAZ et al. dressed a benchmarking of the public street lighting in typical road in Morocco. The study deals with a comparison between the conventional technology used in Moroccan road and the LED technology. The simulated system is based on road with two directions and a sidewalk, three arrangements type of pole layout are treated (Left, Middle and Two sides arrangement). In this paper authors dealed with a parametric analysis based on the variation of boom angle, light Center high and the pole distance in order to determine the luminance of each arrangement at each pole distance. LandGEM is a numerical model based on a first-order decomposition rate modeling equation to quantify emissions from the decomposition of landfill waste in municipal solid waste landfills. DRISSI EL BOUZAIDI et al. demonstrated that modeling with LandGEM offers a wide field of analysis and makes it possible to define the reasons of malfunction following the deviations found in relation to the experimental analysis accomplished on site using estimation of methane gas emissions from landfill site and quantify the energy potential methodology.

Robotics depends on modeling their behaviors as complex systems. ELKARI et al. conducted a comparative study w using Python and Pmaze to evaluate the performance of DFS, BFS, and A* search algorithms in path planning for a maze. The main objective of the project was to compare the efficiency of these algorithms in terms

of path cost and algorithmic complexity.The objective after that is to include a physical robot.3D-Skeleton-based action recognition has been widely adopted due to its efficiency and robustness to complex backgrounds. MOUTIK et al. proposed a novel approach to represent the spatial-temporal skeleton features, along with the present nearby objects and their dynamics. To accomplish this, a new formulation named object knowledge is presented, which entails the categorization of object characteristics, based on whether or not the object necessitates a motion analysis.

In finance, Portfolio optimization problem is that of constructing a portfolio of assets that achieves a desired expected return while minimizing risk. The portfolio selection problem can be formulated as an optimization problem, named Mean Variance Optimization (MVO), with a quadratic objective function that depends on the portfolio's asset allocation and linear constraints that represents the portfolio's asset allocation restriction. M. ZIANE et al. explored the fundamental nature of Portfolio optimization problem, provided a comparative study for understanding the different models used to resolve them. This study was conducted theoretically and experimentally. OUHMID et al. introduced an innovative mathematical model for growing items, with a particular emphasis on broiler chicken production within the context of Moroccan agriculture. The main goal of their proposal is to determine the optimal order quantity of items that the inventory should purchase to satisfy customer demand and the corresponding cycle duration. They opted to use a Staircase function to describe mortality, with more subdivisions to make the function closer to reality. Furthermore, for the first time, their model incorporates three distinct feeding types—Starter Feed, Grower Feed, and Finisher Feed.

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