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EDITORIAL

Introduction to the Special Issue on Computational Intelligent Systems for Solving Complex Engineering Problems: Principles and Applications

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Computational Intelligent (CI) systems represent a pivotal intersection of cutting-edge technologies and complex engineering challenges aimed at solving real-world problems. This comprehensive body of work delves into the realm of CI, which is designed to tackle intricate and multifaceted engineering problems through advanced computational techniques. The history of CI systems is a fascinating journey that spans several decades and has its roots in the development of artificial intelligence and machine learning techniques. Through a wide array of practical examples and case studies, this special issue bridges the gap between theoretical concepts and practical implementation, shedding light on how CI systems can optimize processes, design solutions, and inform decisions in complex engineering landscapes. This compilation stands as an essential resource for both novice learners and seasoned practitioners, offering a holistic perspective on the potential of CI in reshaping the future of engineering problem-solving.

Given the growing significance of these systems, the focus of this thematic issue is to provide insights into the utilization of these algorithms/systems for addressing challenges within engineering fields. This collection includes twelve papers, each concisely outlined in the subsequent paragraphs. The strategies employed in these papers hold the potential for careful adaptation by researchers to tackle issues beyond their immediate domain, encompassing various engineering contexts.

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The first paper, titled "Migration Algorithm: A New Human-Based Metaheuristic Approach for Solving Optimization Problems" [1], introduced a novel metaheuristic algorithm, the Migration

Algorithm (MA), inspired by human migration processes, to address optimization challenges. MA is structured in two phases, reflecting the exploration and exploitation facets of migration dynamics. During the exploration phase, updates to the population simulate the selection of migration destinations. The exploitation phase updates the population by adapting to new environments. The performance of MA was extensively assessed across benchmark functions and compared to twelve established metaheuristic algorithms. The results highlight MA's effectiveness in achieving a harmonious balance between exploration and exploitation, consistently outperforming competing algorithms across various benchmark scenarios.

The second paper, titled "Quantum-Inspired Equilibrium Optimizer for Linear Antenna Array" [2], introduced a quantum-inspired equilibrium optimizer algorithm that integrates quantum computing with equilibrium optimization to tackle linear antenna array optimization. The algorithm's effectiveness and robustness were validated by testing the reduction of the maximum side lobe level in antenna arrays of different sizes. The authors' comparative analyses revealed that the quantum equilibrium optimizer (QEO) outperforms other algorithms in terms of convergence speed and search accuracy, demonstrating its strong competitiveness.

The third paper, titled "An Enhanced Elite Slime Mould Algorithm for Engineering Design" [3], aimed to enhance the performance of the widely adopted slime mould algorithm (SMA) in engineering applications. To achieve a better balance between exploration and exploitation, the paper introduced an improved version known as ECSMA, which integrated elite and chaotic stochastic strategies. The effectiveness of ECSMA was confirmed through comparative analyses, diversity evaluations, and comparisons with other methods. Experimental results demonstrated the significant improvement brought about by these mechanisms within the SMA framework, showcasing its prowess in addressing intricate structural design problems.

The fourth paper, titled "Improved Prediction of Slope Stability under Static and Dynamic Conditions Using Tree-Based Models" [4], proposed two tree-based models, namely reduced error pruning (REP) and random tree (RT), for predicting slope stability, a critical aspect in preventing and mitigating landslide disasters. The authors utilized a comprehensive database containing slope stability data categorized as stable and unstable for their analyses. The findings revealed that the RT model achieved superior prediction performance, followed by the REP tree model. These results highlight RT's reliability and effectiveness in slope stability prediction, suggesting its potential for further research in this area.

The fifth paper, titled "Novel Hybrid XGBoost Model to Forecast Soil Shear Strength Based on Some Soil Index Tests" [5], aimed to estimate soil shear strength through an innovative predictive model for using a combination of extreme gradient boosting (XGBoost) and the salp swarm algorithm (SSA). The role of SSA was to automatically find the optimal hyperparameters of XGBoost in the whole system. By comparing SSA-XGBoost with the base XGBoost, the authors demonstrate the hybrid model's superiority in predicting soil shear strength. The study showcases the practical applicability of this hybrid model with additional and unseen data, further solidifying its effectiveness.

The sixth paper, titled "Predicting the Thickness of an Excavation Damaged Zone around the Roadway Using the DA-RF Hybrid Model" [6], presented a hybrid prediction model based on the random forest (RF) and dragonfly algorithm (DA) models to accurately forecast the excavation damaged zone (EDZ) thickness after roadway excavation. Destruction of the original stress balance during excavation leads to stress redistribution and the formation of an EDZ around the roadway, making EDZ thickness crucial for stability assessment and support design. Comparative analysis with classic models demonstrated that the DA-RF model outperforms others in terms of prediction accuracy, rendering it suitable for future studies with similar objectives.

The seventh paper, titled "An Improved Bald Eagle Search Algorithm with Cauchy Mutation and Adaptive Weight Factor for Engineering Optimization" [7], focused on enhancing the performance of the bald eagle search (BES) algorithm through the introduction of an upgraded version known as the Cauchy Adaptive Bald Eagle Search algorithm (CABES). The aim was to address BES's limitations by integrating Cauchy mutation and adaptive optimization techniques, thereby improving its ability to escape local optima. The study conducted experiments using CEC2017 benchmark functions, comparing CABES with other optimization algorithms. The results underscored CABES's robust exploration and exploitation capabilities, positioning it as a competitive solution among the algorithms tested. Additionally, the paper demonstrated CABES's practical applicability in engineering scenarios, reaffirming its effectiveness and efficiency in real-world optimization challenges.

The eighth paper, titled "Language Education Optimization: A New Human-Based Metaheuristic Algorithm for Solving Optimization Problems" [8], developed a new human-based metaheuristic algorithm named Language Education Optimization (LEO) for solving optimization problems, addressing the notion of the No Free Lunch (NFL) theorem. Drawing inspiration from the dynamics of foreign language education, where students learn from instructors, LEO comprises three phases: students selecting teachers, collaborative learning among students, and individual practice, encompassing both exploration and exploitation. The algorithm's effectiveness was evaluated across fifty-two diverse benchmark functions, encompassing unimodal and multimodal types, as well as the CEC 2017 test suite. The findings underscore LEO's adeptness in exploration, exploitation, and maintaining a balance between the two, showcasing its efficacy in optimization tasks.

The ninth paper, titled "Technique for Multi-Pass Turning Optimization Based on Gaussian Quantum-Behaved Bat Algorithm" [9], introduced a Gaussian quantum-behaved bat algorithm (GQBA) to address the optimization challenges in multi-pass turning operations, a commonly used machining method in manufacturing. GQBA incorporates two key enhancements: firstly, by integrating the optimal positions of quantum bats and the global best position into the stochastic attractor, it enhances population diversification. Secondly, it utilizes a Gaussian distribution instead of a uniform distribution to update quantum-bat positions, resulting in more accurate searches and avoidance of premature convergence. Comparative experiments involving thirteen benchmark functions highlight GQBA's superior search capability.

The tenth paper, titled "Prediction of Flash Flood Susceptibility of Hilly Terrain Using Deep Neural Network: A Case Study of Vietnam" [10], utilized machine learning techniques such as deep learning neural network (DL), Correlation-based Feature Weighted Naive Bayes (CFWNB), and Adaboost (AB-CFWNB) to generate flash flood susceptibility maps for a specific case study in Vietnam. While all models displayed favorable performance, the DL model stood out with the highest accuracy. The authors suggested that the DL model proves to be a valuable tool for producing accurate flash flood susceptibility maps, providing valuable insights for informed infrastructure planning, highway design, and land use management.

The eleventh paper, titled "Seismic Liquefaction Resistance Based on Strain Energy Concept Considering Fine Content Value Effect and Performance Parametric Sensitivity Analysis" [11], presented Artificial Neural Network (ANN) models to estimate the liquefaction resistance of sandy soil using capacity strain energy (W) and laboratory test data. The study compared the performance of the proposed models with four existing models using 20 new samples, showcasing their enhanced accuracy. Additionally, a Monte Carlo Simulation was employed for parametric sensitivity analysis, highlighting the notable impact of grading parameter uncertainties on soil liquefaction resistance.

The final paper, titled "Novel Soft Computing Model for Predicting Blast-Induced Ground Vibration in Open-Pit Mines Based on the Bagging and Sibling of Extra Trees Models" [12], aimed to predict blast-induced ground vibration (peak particle velocity, PPV) in open-pit mines using a combination of machine learning algorithms, particularly employing bagging and sibling techniques. Four foundational machine learning algorithms—support vector regression (SVR), extra trees (ExTree), K-nearest neighbors (KNN), and decision tree regression (DTR)—were initially used for PPV prediction. The subsequent application of the bagging regressor (BA) aimed to enhance the accuracy of these base models. Following a comprehensive process of model construction and evaluation, the authors introduced the BA-ExTree model, which demonstrated the highest predictive performance for evaluating PPV in mining or quarry environments.

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