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Guest Editorial

Soft computing and intelligent systems: Techniques and applications

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This special issue is a collection of 50 selected and extended papers submitted to the Seventh International Symposium on Intelligent Systems Technologies and Applications (ISTA'23) held in Bangalore, India, in parallel with with the International Conference on Applied Soft Computing and Communication Networks (ACN'23), December 18-20, 2023. These papers have been double-blindly peer reviewed and accepted for presentation at the symposium. A second review has been conducted to improve the content and presentation of the manuscripts to be published in this special issue. These papers cover a wide range of powerful techniques including machine learning, explainable AI, and fuzzy systems as well as multiple applications in natural language processing (NLP), speech processing, computer vision and image understanding, security informatics, big data analytics, decision-support systems and business intelligence, social media analytics and recommendation systems, information retrieval and knowledge-based systems, health informatics and medical diagnostic, resource allocations in communication systems, and smart sensing and intelligent Internet-of-Things (IoT). A summary of the contributions of these papers pertaining to various application domains is presented in the following sections.

1. Natural language processing (NLP) and speech processing

There are 9 papers in this special issue covering topics related to this category. The first paper [1] implements five different multi-label classification algorithms using 14 different base classifiers and compares the performance on four different datasets named as Bibtex, Birds, Emotions and Enron. The paper also applies statistical hypothesis test to evaluate whether the difference in the mean performance between any two algorithms is real or not in order to select the best approach.

Non-autoregressive machine translation (NAT) is addressed in [2], which is another important problem in NLP. It enables simultaneous improvement of prediction quality of output tokens as well as significant boost of translation speeds. The study concentrates on exploring knowledge distillation technique in NAT

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and applying it to Kashmiri Indic language to English translation. Results show that the proposed method attains sacreBLEU scores ranging from 16.20 to 22.20.

A challenging task in NLP is Neural Machine Translation (NMT) for low resource languages due to unavailability of large parallel corpus. In [3], the authors performed a series of experiments to study the impact of hyperparameters using an open-source Hindi-Kangri corpus for both supervised and semi-supervised NMT models. The study in [4] presents an innovative platform for visually impaired children to share their narratives by translating Braille-authored stories into spoken Malayalam and Tamil languages. Furthermore, the explainability was built into the model using the XAI-SHAP tool to find the dominating features for classification.

In [5], a combination of stacked Bidirectional Long Short-Term Memory (BiLSTM) architecture and a one-dimensional Convolutional Neural Network (CNN) is proposed for predicting tongue and lip articulatory features involved in a given speech acoustics. This model is trained on two datasets and assessed in Speaker Dependent (SD), Speaker Independent (SI), corpus dependent (CD) and cross-corpus (CC) modes.

In [6], the effectiveness of speech-based features, including MFCC, zero crossing rate, spectral centroid, spectral bandwidth and chroma STFT, is investigated for COVID detection from audio recordings using multiple machine learning algorithms along with various data augmentation techniques. Results on Coswara speech database indicated that a combination of the best 20 features gave a comparable performance to the entire feature set with a higher recall rate.

Real-time multilingual conversations is paramount becoming increasingly essential to facilitate the communication between people speaking different languages worldwide. In [7], an intelligent peer-to-peer polyglot voice-to-voice mobile application supporting five languages is introduced to enable people in close distance to interact with others transparently using their preferred language. The application can automatically recognize the language, gender of the speaker, and spoken words with very high accuracy. Another study for demographic speaker recognition is presented in [8]. The aim of this paper is developing a bimodal demographic recognition system for Arabic speakers from audio and associated textual modalities. This system is based on AraBERT transformer and AlexNet architecture and is capable of detecting age groups, genders, and dialects; but it can be easily extended to incorporate more demographic traits.

Speech Emotion Recognition (SER) is another important application that has received considerable attention over the past 20 years for monolingual, multilingual and cross-corpus contexts. In [9], a self-recorded database has been developed to include speech emotion samples with 11 diverse Indian languages and various machine learning and deep learning approaches have been applied for emotion recognition. The proposed approaches use GeMAPS (Geneva Minimalistic Acoustic Parameter Set) feature set enriched with MFCC (Mel Frequency Cepstral Coefficients) coefficients as proven to be more robust.

2. Computer vision, pattern recognition, image understanding, image retrieval, health informatics, and computer-aided diagnosis

Seventeen papers are included in this special issue, where various deep learning architectures have been investigated on different applications of computer vision, pattern recognition, image and video processing and understanding, content retrieval and healthcare informatics systems, and computer-aided diagnosis.

In [10], an enhanced deep learning approach is proposed for image dehazing to improve the quality images affected by atmospheric conditions. The proposed CNN network involves additional layers for Channel Attention and Pixel Attention layers, and has been tested with four state-of-the-art CNNs: GMAN, U-Net, 123-CEDH and DMPHN.

Several applications of computer vision including medical and Satellite image analysis requires incredibly high resolution images. The work in [11] proposes a novel CGIHE-VDSR algorithm that integrates the Very Deep Super Resolution Network with Color Global Picture Histogram Equalization to improve image resolution. This method uses a low-resolution image histogram equalization before applying the VDSR network. The proposed method outperforms existing methods in PSNR and SSIM metrics. Restoring local region features and maintaining sharper video frames is another important problem in video super-resolution applications. In [12], a Conformation Detail-Preserving Network (CDPN), called SuperVidConform, is proposed for gener-

ating high-resolution frames from low-resolution ones, decomposing confirmation details and learning local region features through residual learning. The approach is evaluated on three datasets: VID4, SPMC, and UDM10, and demonstrated new standard benchmark results for self-generated surveillance datasets.

Fusing information from multiple modalities in computer vision and information retrieval is the focus of the work presented in [13]. The aim of this work is to explore the combination of NLP with computer vision tasks for image-to-text conversion to leverage the quality of retrieved content. Five experiments have been conducted on the benchmark Flickr8k dataset using different architectures such as simple sequence-sequence model, attention mechanism, and transformer-based architecture. Although convolutional neural network have shown great success in image processing and computer vision tasks, structural features, such as joint location in gesture recognition, may not align well with a grid-like architecture. In [14], a Gesture Analysis Module Network (GAMNet) is introduced to compute abstract structural values within the architecture for feature extraction, prioritization, and classification.

Content-Based Image Retrieval (CBIR) is a technique that uses deep learning to automatically extract similar images from large databases. In [15], a cascaded network is used for feature extraction, employing multi-modal features and a Convolutional Siamese Neural Network (CSNN). The network uses pseudo-labeling to categorize images based on their affinity and similarity to the query image. System's performance on the Oxford dataset shows significant improvements in precision, error rate, and false positive rate, proving effective for interconnected device images.

Several papers focus on applications in medical field. For example, in [16] a hybrid deep learning model is presented for pediatric pneumonia detection, leveraging the EfficientNetV2 model. The model maintains a balance between model scaling and performance in pediatric pneumonia detection, using global weighted average pooling (GWAP) and kernel-based principal component analysis (K-PCA). The reduced features are combined into a stacked classifier, employing a support vector machine (SVM) and random forest tree (RFT) for prediction. Experiments on publicly available benchmark datasets showed the model improved accuracy by 4% in P-Pneumonia detection. The model was also tested on completely unseen datasets and on similar lung diseases like COVID-19 and Tuberculosis. The model's robustness and generalizability make it suitable for healthcare and clinical environments, helping doctors and healthcare professionals improve detection rates.

The study in [17] collected data from four eye hospitals in India and applied a rescaled version of Resnet-101 with SVM in the last layer to identify the damaged retina with very high accuracy. Another problem related to early detection of oral cancer lesion is considered in [18] using a deep learning model composed of CaG mask R-CNN. This study also applied a Genetic Algorithm with chaotic logistic map initialization for tuning hyperparameters. This model was tested on a dataset collected from an Indian hospital and compared with three versions of the YOLO models.

Glaucoma is another eye disease that requires early detection and proper diagnosis for timely intervention and treatment. In [19], the authors propose a model-based Reinforcement Learning (RL) approach, called DynaGlaucoDetect, with ocular gaze data to simulate and predict the dynamics of glaucoma and improve the accuracy and efficiency of glaucoma detection.

Macula is a sensitive part of the human vision system and is affected by macular edema, caused by intraretinal fluid (IRF) accumulation. This swelling can lead to vision impairment and ocular diseases. Optical coherence tomography (OCT) is a major tool helping ophthalmologists to visualize edema. In [20], a method combining convolutional neural networks and active contour models is proposed to segment the IRF and determine macular edema severity. The method doesn't require labeled images for training and shows superior performance and consistency compared to other methods.

In [21], authors explore ensemble feature selection with Jenson-Shannon divergence to evaluate the robustness of feature selection for detecting the polycystic ovary syndrome (PCOS). This represents a hormonal condition that typically affects female during the time of their reproduction. Additionally, a hybrid model using SMOTE-SVM is proposed and compared with other machine learning methods including KNN (K-Nearest Neighbour), Support Vector Machine (SVM), AdaBoost, LR (Logistic Regression), NB (Nave Bayes), RF (Random Forest), and Decision Tree.

In [22], a method is proposed to extract the fetal region contour in ultrasound images and calculate the Crown-Rump Length (CRL) based on the U-Net architecture with Channel and Spatial Activation

mechanisms. COVID-19 is causing a myriad of neuropsychiatric conditions that increase hypnotic susceptibility. The study in [23] uses a voice recognition engine known as GEOGRIE to measure the hypnotic susceptibility of people who have recovered from COVID infections using a digitized Harvard Susceptibility Scale.

3. Security and security informatics

Software-Defined Networking (SDN) is a modern networking architecture that offers flexibility for network changes but also poses security issues like DDoS attacks. In [24], the authors proposed a Kafka Streams-based real-time DDoS attacks classification approach for the SDN environment, called KS-SDN-DDoS. The approach uses scalable H2O ML techniques on the Apache Hadoop Cluster and consists of two modules: Network Traffic Capture (NTCapture) and Attack Detection and Traffic Classification (ADTClassification). The approach was validated using the DDoS Attack SDN dataset and showed 100% classification accuracy.

In [25], the authors discuss the vulnerability of the 4G long-term evolution (LTE) wireless broadband communication systems to attacks such as denial-of-service and location leaks. Moreover, they propose and evaluate a novel authentication scheme to mitigate these vulnerabilities using Network Simulator 3. Numerical analysis shows that the proposed approach significantly reduces communication overhead and computational costs associated with the 4G LTE authentication mechanism. The paper also investigates how these attacks occur and expose communication in the 4G network.

4. Big data analytics, information retrieval, knowledge-based systems, decision support systems, supply chains, business intelligence

Decision support systems are essential in various sectors but lacks transparency and interpretability, raising concerns about their reliability, accountability and fairness. In [26], the authors explore the computational complexity challenges of explainable decision support systems (XDSS) in decision support systems. The paper discusses the motivations behind explainable AI, their explanation methods, and their trade-offs between complexity and interpretability. The review provides insights into the current state of computational complexity within XDSS and future research directions.

Predicting stock market changes is a prominent problem for big data and machine learning applications. However, the stock market is challenging to predict due to various variables, including economic indicators and global events. Fundamental analysis involves analyzing a company's financial and economic data to predict stock price possibilities. Experts use techniques like technical indicators, trends, charts, and statistical analysis to make informed predictions. In [27], the authors compare various machine learning algorithms fr = or stock market forecasting.

Finding optimal weights for linear combination methods is still a challenging problem for researchers. In [28], the authors use the differential evolution algorithm to optimize the weight of linear combination methods in financial markets. Four multivariate financial time series are used as case studies, and the traditional deep learning methods, namely multilayer perceptron (MLP), long short-term memory (LSTM) network, and bidirectional long short-term memory (BiLSTM) network, are integrated. Results show that the linear combination using differential evolution weight optimization outperforms individual deep learning models and state-of-the-art weight estimations in prediction performance.

Employee retention is another critical problem in contemporary competitive businesses, not only improving organizational performance but also reducing recruitment costs. In [29], the authors use machine learning algorithms and evaluates them on the IBM HR dataset to predict employee attrition, highlighting the importance of job satisfaction, work-life balance, and professional growth. The model has an accuracy of over 80%, aiding companies in identifying at-risk employees and implementing effective retention strategies.

The COVID-19 pandemic has highlighted the importance of effective management in healthcare supply chains. The research in [30] presents a robust MADM methodology called Lq* q-rung orthopair multi-fuzzy soft set (Lq* q-ROMFSS-MADM) for supplier evaluation and ranking. The model's effectiveness is confirmed through experiments on operations like union, intersection, complement, restricted union, and intersection. The model's application in healthcare supply chain management is demonstrated through a multi-attribute decision-making problem and comparative analysis.

The study in [31] introduces a novel similarity measure for lattice ordered q-rung orthopair multi-fuzzy soft sets (Lq* q-ROMFSSs) to improve healthcare waste disposal methods. This innovative approach addresses the challenges of urbanization and waste production, especially in developing countries, and proposes an evaluation methodology that uses this information to determine the optimal waste management approach, thereby improving decision-making and efficiency.

Nature-inspired algorithms are extremely effective in discovery of optimized solutions in multidimensional and multimodal problems. In [32], the authors explore their application in improving the prediction performance of a credit scoring model. Using four benchmark datasets from the UCI repository, the researchers test feature selection using various algorithms, including Random Forest (RF), Logistic Regression (LR), and Multi-layer Perceptron (MLP).

Another study in [33] presents the q-rung linear diophantine fuzzy hypersoft set (q-RLDFHSS) by fusing q-RLDFS with HSS. It discusses lattice ordered q-RLDFHSS (LOq-RLDFHSS) and LOq-RLDFHS Matrix, and proposes a medical diagnosis methodology for patients with comorbidities, i.e., having more than one disease conditions at the same time that require complex and increased cost clinical management. Comparisons are provided between proposed and current theories.

5. Social media analytics and recommendation systems

With the uprising volume of online content, intelligent recommender systems are becoming essential to offer users with a narrow range of personalized suggestions. In [34], a novel approach is presented to intelligent recommender systems, addressing the issue of filter bubbles. It integrates a diversity module into a knowledge graph-based explainable recommender system, enhancing user trust and broadening recommendations. The system will be refined with an explicit feedback loop and NLP techniques, providing users with a wider range of content and insightful explanations.

Analyzing content in various social network platforms has attracted a growing attention in various applications. One of the popular problems is sentiment analysis, which is a method used to understand user attitudes and opinions using text analysis and NLP. In [35], the authors propose a simple, compelling method for analyzing tweets based on positive and negative words, categorizing them as Neutral, Negative, or Positive. The goal is to use a hybrid method combining supervised machine learning and natural language processing techniques for review analysis. The proposed system improves sentiment analysis using machine learning and regular expressions, allowing for objective representation and analysis across different domains.

Social media platforms also play a crucial role during crises. In [36], a new dataset related to COVID-19 pandemics is introduced. It is known as GeoCovax-Tweets dataset and contains 1.8 million geotagged tweets originating from 233 countries and territories from January 2020 to November 2022. The study aims to provide valuable insights for crisis computing researchers, more specifically COVID-19 vaccines, enabling them to explore trends, opinion shifts, misinformation, and anti-vaccination campaigns in Twitter conversations surrounding the pandemic. The study in [37] analyzes informal crisis-related social media texts by classifying disaster event tweets into 10 humanitarian categories. It fine-tunes and compares several pre-trained transformer models. The study finds CrisisTransformers outperform seven strong baseline transformer models, achieving a macro-averaged F1 score of 0.77. This contributes to crisis computing and enhances emergency responder capabilities.

6. Mobility management resource allocations in communication systems, and smart sensing and intelligent Internet-of-Things (IoT)

A number of papers are related to low-power wireless networks, smart sensors and Internet-of-Things (IoT) data analytics, intelligent mobility management, and intelligent management of limited resources. For example, in [38], the authors suggest improving the metrics linked to the objective function to reduce node energy consumption and improve service quality. They employ received signal strength indicator, node distance, receiver power, and link quality indicator information to train a nonlinear support vector machine to predict the lowest power required. The Takagi-Sugeno fuzzy model is used to calculate the objective function value of the candidate node based on the power level and expected transmission count in order to choose reliable communication links. Cooja simulator is used to implement the pro-

posed approach and against minimum rank with hysteresis OF and OF zero and significant gains in the packet delivery ratio and a 37.5% decrease in energy usage are achieved. Another example is presented in [39], where a joint computational and optimized resource allocation (JCORA) technique is proposed to speed up data processing from intelligent IoT sensors.

To maximize user fairness and save data processing time, the suggested method makes use of an uplink and downlink power allocation factor as well as the shortest job first (SJF) task scheduling system. This problem is a complex assignment problem due to multiple non-convex limitations. To maximize the weighted total of task processing and communication performance, the proposed JCORA-SJF model jointly optimizes target sensing location selection, computing task processing mode selection, and time partitioning. The paper also investigates the efficiency and scalability of the proposed method.

The next generation of internet protocol is evolving to address the arising use of mobile devices to support continuous services across networks. In [40], the researchers propose a secure and efficient binding update scheme (One-CLU) for mobile devices, incorporating a one-key-based cryptographically generated address (CGA). This scheme uses AVISPA to verify security correctness and reduces communication payloads and costs for binding update, binding refresh, and packet delivery. The proposed scheme addresses security threats and ensures the reachability of mobile devices at home networks.

Web applications are crucial for managing businesses in the future smart world. Creating a web application in the cloud offers affordable, scalable, and secure services, eliminating server setup and maintenance. In [41], the authors propose a MCDM technique to solve real-world Minimum Spanning Tree problems, combining existing algorithms, namely Hamacher aggregation operator and Kruskal's technique. This technique is demonstrated for marketing web applications in a future smart world using LiFi technology, which is crucial to overcome constraints like scalability, security, and bandwidth.

With the expansion of IoT devices that require latency-free communication in time-critical applications has proven a drawback of cloud-based services. The study in [42] examines the usability of edge computing devices in smart traffic surveillance use cases. It identifies suitable edge devices for computation offloading and develops an optimization algorithm to generate an optimal schedule. The results show that edge devices outperform local execution by nearly 11 times, demonstrating the feasibility of resource-constrained edge devices in edge computing. This approach addresses privacy concerns and improves energy and execution time in time-critical applications.

7. Smart-home, smart-energy and smart-industry systems

The W3C linked building data group is developing interoperable ontology-based models using semantic web technologies, such as ifcOWL and Building Topology Ontology for Smart Homes (BOTSH), to integrate building information with building life cycle data. The Semantic Web of Things (SWoT) group also proposed standard semantic models such as M3-lite and BOSH ontologies for describing the sensor networks, observations, and sensor measurements. In [43] an interoperable ontology is proposed to align the building domain with the sensors domain semantic models, facilitating the capture of knowledge from both domains. The potential of the proposed model was demonstrated using a real-life building model, demonstrating its potential in developing cross-domain applications.

Energy is a critical resource that requires continuous monitoring for efficient use and reduction of energy waste and the substantial concerns on global warming and climate change. In [44], the authors propose a lightweight model for multi-target non-intrusive load monitoring based on MobileNet architectures. The results show significant reduction in errors and that MobileNetV3-large is the most appealing for energy disaggregation, requiring 55% less storage and 66% less training time than MobileNetV2.

The global industrialization leads to an increase in vehicles and engines, but the scarcity of fossil fuels has led to a need for alternative fuels. The study in [45] identifies a hybrid structure of a linear diophantine multi-fuzzy soft set as a suitable alternative to petrol. The method's applicability and effectiveness are evaluated through a case study and comparative analysis, demonstrating its potential and benefits over existing methods.

The alternative solution for fossil-fueled vehicles is Electric Vehicles (EVs). In [46], the authors explores the estimation of State of Health (SoH) for electric vehicles using four machine learning algorithms:

Feed Forward Neural Network (FNN), Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU). These methods are evaluated and compared using different performance metrics, highlighting the importance of battery management systems in EVs.

Navigation of a mobile robot in an unknown environment is of utmost importance in several applications. The study in [47] uses a deep reinforcement learning strategy, specifically the Deep Q-Learning algorithm, to navigate a mobile robot in an unknown environment, while ensuring the safety of the robot and its surroundings. The proposed model is trained using a federated learning approach to overcome privacy issues and improve generalization. The application scenario involves a robot moving to a charging point in a greenhouse environment. Both traditional and federated deep reinforcement learning frameworks achieve 100% success rates, with federated deep reinforcement learning potentially being a better alternative.

Agricultural research is a prominent area that has several smart applications for machine learning and robotics. In [48], the authors introduce an innovative method for estimating mangosteen fruit size using the YOLOv5 deep learning model and macro-camera images. The algorithm's real-time processing reduces manual intervention and improves data collection efficiency. Field trials showed an outstanding training accuracy of 99.5% by the 20th epoch, significantly improving accuracy and efficiency compared to traditional methods. The fruit size estimation technique was verified using the magnification formula of the lens, yielding a negligible relative error of 3%.

Another area of great importance is the application of deep learning in manufacturing industry and software development. In [49], a method is presented based on Convolutional Neural Network (CNN) model for detecting defects in semiconductor wafers fabrication. The model is consisting of nine layers and is demonstrated to classify defects with high confidence and accuracy, achieving 99.1% accuracy. Implemented in FPGA, the model is less complex and consumes less computational power than conventional methods, proving its potential in the complex process of semiconductor wafer fabrication. Software fault prediction is an essential component of software quality assurance. In [50], the authors examine the use of feature ranking algorithms for successful software fault prediction. The study examines the effectiveness of multiple machine learning classifiers on six different software projects. SVM and RF performed well, with SVM achieving 98.74% accuracy on "jedit" and 91.88% on "tomcat" and RF achieving 89.20% accuracy on "ivy". NB was the least successful classifier, indicating that the choice of feature ranking algorithms significantly impacts the predictive accuracy and effectiveness of fault prediction models.

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