Computer Assisted Methods in Engineering and Science
30(1): 3–6, 2023

Preface to Special Issue on Information Theory with Artificial Intelligence in 5G/6G Networks

Mutual/single information theory has been the theoretical background of old and advanced communication systems. Information theory has shown innovative directions for future breakthroughs at each critical evolution stage of mobile communication generation. Modern wireless communications revolve around infinitely more complicated topologies, which often include multiple users, fluctuating channel strengths, and nodes that cooperate or compete. The network's size increases proportionately, and the information transmission becomes more complex. The applications of AI and ML technologies in wireless communications have drawn significant attention recently in information theory. AI has demonstrated tangible success in speech understanding, image identification, and natural language processing domains, thus exhibiting its great potential in solving problems that cannot be easily modelled. AI techniques have become an enabler in wireless communications to fulfil the increasing and diverse requirements across an extensive range of application scenarios in modern 5G/6G networks. There are several typical wireless scenarios, such as channel modelling, channel decoding and signal detection, and channel coding design, in which AI, ML and deep neural networks play an important role in wireless communications.

This special issue aims to encourage researchers to present original and recent developments inn information theory to analyze what lies in 5G/6G networks. It focuses on the fundamental theory, performance limits, design, and management issues in 5G/6G communication systems. For this purpose, comprehensive overviews and surveys for future networks and original papers related to these techniques are proposed. This issue is composed of 6 outstanding contributions.

Sudarshan S. Sonawane and Satish R. Kolhe [1] proposed a novel multi-label classification of sentiment polarity called handling dimensionality of ambiguity using the ensemble classification (HAD-EC) method, which diffuses ambiguity and thus minimizes false alerts. Classifying tweets according to their sentiment polarity can determine whether they express a good, negative, or neutral opinion, or an input tweet irrelevant to the sentiment polarity context. The experimental assessment validates the HAD-EC approach by comparing the suggested model's performance to other two existing models. The purpose of this article was to describe how to overcome the sentiment analysis's curse of ambiguity. The objective

was to conduct ensemble learning and sentiment polarity prediction on a given corpus by using the fuzzy c-means method to split it into multiple fuzzy clusters. The fuzzy c-means clustering and ensemble classification techniques were used to perform sentiment polarity identification based on aspects. In contrast to other current techniques, the suggested fuzzy clustering splits the provided corpus into numerous groups, with each cluster containing one or more records. When individuals employ ambiguous phrases, they frequently associate them with a variety of possible meanings. As a result, clusters are defined by centroids. In this study, an ensemble supervised learning model is presented to determine the sentiment polarity of multiple labels classified as positive, negative, neutral, and not relevant. The study examined a corpus of Apple tweets. The cross-validation metrics produced from the ambiguity in sentiment classification and aspects oriented sentiment polarity models were compared to those predicted by the HAD-EC model. According to the findings of the performance metrics, the proposed model outperforms the existing models in predicting sentiment polarity in ambiguous social media data.

S. Vamsee Krishna *et al.* [2] offered the design and verification of sigma-delta modulators that are presented at the system level with high accuracy and computational efficiency. Sigma-delta analogue to digital converters showcased an excellent choice for low bandwidth applications from near DC to high bandwidth standard 5G applications. The conceptualization of the graphical user interface – in the efficient selection of integrator weights has been proposed, which solves various tradeoffs between various abstraction levels. The sigma-delta modulator of the fifth order is designed and simulated using the proposed design methodology of calculating integrator weights for targeted specifications. The efficiency of design exploration and optimum selection of integrator coefficients has been investigated on single-loop architectures. The power and performance of the selected modulator have been verified in the time domain behavioural simulation. The discrete-time circuit technique has been adopted for the design of distributed feedback, feed-forward architectures and comparison of performance metrics done between selected architectures. A huge design space is computed for the best design parameters that offer ultra-low power and high performance. The proposed virtual instruments supported the methodology for designing delta-sigma modulators at the system level achieving an SNDR of 122 dB over a bandwidth of 5 kHz at a clock frequency of 1 MHz.

M.T. Thirthe Gowda and J. Chandrika [3] explored the efficiency of hybrid texture and colour gradient for a dynamic background subtraction system using 5G data services. Statistical texture and colour gradients were combined to identify the background and subtract it from foreground regions. This method was examined on several tobacco plant videos with dynamic background variation and real-time outdoor fields, and the performance validation in terms of detec-

tion accuracy and its consistency toward different nonlinear video dynamics confirms the robustness of the proposed plant detection system. The incorporation of multimodal feature attributes during template modelling comprising uniform and rotational invariant textures and colour gradients showed that an optimal background model could ensure dynamic BS efficiently with improved robustness and reliability. Experimental evaluation of two datasets shows that the new model achieves superior performance over existing results in the spectral-domain disease identification model.

K. Neelima and S. Vasundra [4] attempted a methodology for designing ensemble machine learning techniques and approaches for classifying and segmenting registered numbers of registered title records to choose the most suitable business rule that can convert the registered number into the format the business expects, allowing businesses to provide customers with the most recent data in less time. This study evaluates the suggested model by gathering sample data and analyzing classification ML models to determine the relevant business rule. Experimentation employed Python, R, SQL stored procedures, Impala scripts, and Datameer tools. This work illustrated the benefit of applying the hybrid ensemble technique, and found that for the complex text-based title registered documents, random forest and decision tree methods provided optimal performance based on the metrics considered for the evaluation.

Venkatasivanagaraju S. and M. Venkateswara Rao [5] explored cuckoo search (CS) to optimize the obtained parameters that help to minimize parameters in the predecessor and consequent units of each sub-model. The proposed approach is used to estimate the power load in the local area. The constructed models show excellent predicting performance based on derived performance. The results confirm the method's validity. The outcomes are compared with those obtained by using the NR method. CSA outperformed the other methods in this investigation and gave more accurate predictions. The OPF problem is solved via CSA in this study. Implementing a real-time data case bus system is recommended to test the performance of the established method in the MATLAB programme.

Ch. Pratyusha Chowdari and J. Beatrice Seventline [6] aimed at a novel systolic 2D block finite impulse response filter architecture using a distributed arithmetic-based multiplexer look-up table (DA-MUX-LUT). The proposed architecture computes the instantaneous partial product using the bit vector. The switching-based LUT replaces memory-based structures and reduces hardware complexity. Block processing allows memory reuse, which reduces the number of registers to store the previous input samples. Parallel adders are substituted by a modified carry look-ahead adder, which minimizes the delay. Moreover, a resource-sharing concept is introduced to the DA-MUX-LUT block that drastically reduces the adder requirement. The proposed method is well-suited for applications that require very high processing.

We would like to express our gratitude and congratulations to all the authors of the selected papers in this special issue for their contributions of great value in terms of quality and innovation. We would like to thank also all the reviewers for their contribution to the selection and improvement process of the publications in this special issue. Our hope is that this special issue will stimulate researchers in academia and industry to undertake further research in this challenging field. We are also grateful to Prof. M. Kleiber and Prof. T. Burczyński, Editors-in-Chief of *Computer Assisted Methods in Engineering and Science* and the Editorial Office for their support throughout the editorial process.

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