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EDITORIAL

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Special Issue on Computational Intelligence Techniques for Industrial and Medical Applications

1 | INTRODUCTION

Computational Intelligence techniques are adopted in many industrial applications, like visual-based quality control, image enhancement in consumer electronics, image quality enhancement, video-based recognition of identity or behaviors, audio-based speech recognition for enhanced human like interaction with machines, and so on. It also has a strong impact in medical applications, like medical image enhancement, semiautomatic detection of pathologies, prefiltering and reconstruction of volumes from medical scans, and so on. Despite this growing diffusion, there are still many possible areas where computational intelligence application is partial or could be extended and improved due to the actual limitations in terms of computational power or strict requirements in terms of assurance of the results.

2 | THEMES OF THIS SPECIAL ISSUE

Starting from the above considerations, this special issue aims to investigate the impact of the adoption of advanced and innovative Computational Intelligence techniques in industrial and medical applications including the ones that takes advantage of recent Big Data Architectures. This edition of the special issue is focused primarily on signal processing for industrial and medical applications with special emphasis to stream processing and Big Data platforms. This issue is intended to provide a highly recognized international forum to present recent advances in *Concurrency and Computation: Practice and Experience*. We welcomed both theoretical contributions as well as articles describing interesting applications. Articles were invited for this special issue considering aspects of this problem, including:

- Imaging for industrial applications.
- Computational Intelligence approaches in biomedical signal processing.
- Computational Intelligence approaches in consumer electronics.
- Real-time multimedia signal processing.
- Intelligent user interfaces.
- Virtual-augmented reality for Healthcare.
- Demosaicking and denoising in digital image acquisition pipeline.
- Spatial and temporal estimation and protection of media streams.
- Learning systems for signal and information processing and evidential reasoning for recognition.
- Soft computing approaches for embedded multimedia systems.
- Real-time signal processing and vision.
- Big Data architectures for Computational Intelligence.
- Big Data processing for industrial medical applications.

After review, a total of eight articles out of ten submissions have been accepted for publication in this issue.

2.1 | Models

The contribution by Pavan et al "Energy efficiency and I/O performance of low-power architectures" presented an energy efficiency and I/O performance analysis of low-power architectures when compared to conventional architectures, with the goal of studying the viability of using them as storage servers.[1] Their results show that despite the fact the power demand of the storage device amounts for a small fraction of the power demand of the whole system, significant increases in power demand are observed when accessing the storage device. The authors investigated the access pattern impact on power demand, looking at the whole system and at the storage device by itself, and compare all tested configurations regarding energy efficiency. Then they extrapolated the conclusions from this research to provide guidelines for when considering the replacement of traditional storage servers by low-power alternatives. The authors show the choice depends on the expected workload, estimates of power demand of the systems, and factors limiting performance. These guidelines can be applied for other architectures than the ones used in this work.

With the rapid increase in e-commerce data, recommender systems (RSs) have become the most prevalent methods for providing recommended services in various commercial platforms. Deep learning-based recommender methods improve recommendation results by learning latent representations; however, most cannot capture the correlations between items and ignore additional information, such as time information, which leads to suboptimal suggestions. To improve the recommendation accuracy, the authors in the contribution by Chen et al "A novel recommender algorithm based on graph embedding and diffusion sampling" propose a novel recommender algorithm based on graph embedding and diffusion sampling (graph2vec).[2] Their improved model constructs a graph based on users' behavior histories and embeds the graph to a low-dimensional vector space with a deep learning approach. To obtain a more accurate embedding result, the authors used a revised sampling method based on information diffusion theory to capture both the depth and breadth information of a graph. Then, they recommend the top-N items to the target user depending on the final representation vectors. Experiments are carried out on real-world datasets to demonstrate the performance of graph2vec. The results show that browse-based graph construction and diffuse-based graph embedding help the new model improve the recommender accuracy compared with that of the selected state-of-the-art models.

2.2 | Performance improvements

The contribution by Nasciutti et al "Evaluating optimizations that reduce global memory accesses of stencil computations in GPGPUs" compares the performance of optimizations that transform replicated global memory accesses into local memory accesses on 3D stencil computations in the NVIDIA Tesla K80 GPGPU.[3] The optimizations reduce global memory contention caused by the set of multiprocessors. Evaluated optimizations are grid tiling, inserting spatial and temporal loops into kernels, register reuse, and some of their combinations. A standardized experiment evaluates performance variation with grid size and stencil size for each optimization. Experimental data show that codes that use these optimizations are up to 3.3 times faster than the classical stencil formulation. It also shows that the most profitable optimization varies with grid and stencil sizes.

Big data is largely influencing business entities and research sectors to be more data-driven. Hadoop MapReduce is one of the cost-effective ways to process large-scale datasets and offered as a service over the Internet. Even though cloud service providers promise an infinite amount of resources available on-demand, it is inevitable that some of the hired virtual resources for MapReduce are left unutilized and makespan is limited due to various heterogeneities that exist while offering MapReduce as a service. As MapReduce v2 allows users to define the size of containers for the map and reduce tasks, jobs in a batch become heterogeneous and behave differently. Also, the different capacities of virtual machines in the MapReduce virtual cluster accommodate a varying number of map/reduce tasks. These factors highly affect resource utilization in the virtual cluster and the makespan for a batch of MapReduce jobs. Default MapReduce job schedulers do not consider these heterogeneities that exist in a cloud environment. Moreover, virtual machines in MapReduce virtual cluster process an equal number of blocks regardless of their capacity, which affects the makespan. The authors in the contribution by Jeyaraj et al "Improving MapReduce scheduler for heterogeneous workloads in a heterogeneous environment" devised a heuristic-based MapReduce job scheduler that exploits virtual machine and MapReduce workload level heterogeneities to improve resource utilization and makespan.[4] The authors proposed two methods to achieve this: (i) roulette wheel scheme based data block placement in heterogeneous virtual machines, and (ii) a constrained 2-dimensional bin packing to place heterogeneous map/reduce tasks. They compared heuristic-based MapReduce job scheduler against the classical fair scheduler in MapReduce v2. Experimental results showed that the proposed scheduler improved makespan and resource utilization by 45.6% and 47.9% over classical fair scheduler.

A systematic and profound reading of an electrocardiogram (ECG) is needed to identify the different kinds of cardiac diseases called Arrhythmia. The manual identification of the changes in the ECG pattern over a long period is challenging. This work can be automatized by developing algorithms that run perfectly on a computer or on a smartphone to identify the causes of arrhythmia. The contribution by Arumugam et al "Arrhythmia identification and classification using wavelet centered methodology in ECG signals" includes three stages of analysis: (i) the ECG noise suppression; (ii) RR and PR intervals extraction from the ECG signal; and the (iii) ECG classification.[5] The proposed methodology accurately identified the locations and amplitudes of P, Q, R, S, and T subwaves of the ECG signal using a dedicated wavelet design. Experimental results of the MIT-BIH arrhythmia database records indicate the energy levels of the ECG signal at a decomposition level of 4 and 8 as $3.694e^{+09}$ and $7.148e^{+09}$, respectively. These energy levels are used in deciding the wavelet decomposition levels for feature extraction and classification of the ECG signal. A decomposition level of eight is proposed in this work for perfect feature extraction and classification of the ECG signal. An analysis of subband frequencies obtained in the decomposition of the ECG signal is also performed. The proposed methodology gives a sensitivity of 99.58% and positive predictive value of 95.92% in the ECG examination.

2.3 | Applications

Instruction Reuse is a technique adopted in Von Neumann architectures, which improves performance by avoiding redundant execution of instructions when the result to be produced can be obtained by searching an input/output memoization table for such instruction. Trace reuse can be applied to traces of instructions in a similar fashion. However, those techniques are yet to be studied in the context of the Dataflow model, which has been gaining traction in the high performance computing community due to its inherent parallelism. Dataflow programs are represented by directed graphs where nodes are instructions or tasks and edges denote data dependencies between tasks. The contribution by Rouberte et al "DF-DTM: Dynamic Task Memoization and reuse in dataflow" presents dataflow dynamic task memoization (DF-DTM), a technique that allows the reuse of both nodes and subgraphs in dataflow, which are analogous to instructions and traces, respectively.[6] The potential of DF-DTM is evaluated by a series of experiments that analyze the behavior of redundant tasks in five relevant benchmarks, where up to 99.70% of the instantiated tasks could be reused. Moreover, this article evaluates how reuse rates can be affected by limiting subgraph size, memoization table size, task granularity, and problem size, showing that DF-DTM can yield good reuse rates in more realistic environments.

Industry and medical imaging are technologies and processes of managing subjective representations of the industry product, interior of a body for analyzing. The deinterlacing is the procedure of transforming interlaced signal into progressive one. In the contribution by Jeon "Structure and gradient-based industrial interpolation using computational intelligence," the author proposes a new single field deinterlacing method which has three submethods: bilinear method, small filter-based method, and large filter-based method.[7] Pixels in a given image are grouped into three regions by calculated local mean and variance values: stable region, neutral region, and complex region. To implement deinterlacing process, the author used weight average filter by considering two factors (the likeness factor and the distance factor) and determined region characteristics. Simulation results inform that the presented method yields satisfactory results in objective metrics (peak signal-to-noise ratio, structural similarity index, and implementation time) and subjective quality.

Medical image fusion is a technology of combining multimodal images to generate a composite image, which is favorable to improve the capability of doctors in diagnosis and treatment of the disease. In the contribution by Liu et al "Medical image fusion method by using Laplacian pyramid and convolutional sparse representation," the authors proposed a fusion method by combining Laplacian pyramid (LP) and convolutional sparse representation (CSR) to achieve good performance.[8] In the proposed fusion method, LP transform is performed on each pair of preregistered computed tomography image and magnetic resonance image to obtain their detail layers and base layer. Then, the base layer is fused with a CSR-based approach, whereas the detail layers are merged using the popular "max-absolute" rule. Finally, the fused image is reconstructed by performing the inverse LP transform over the fused base layer and detail layers. The advantages of the proposed method are that the texture detail information contained in source images can be fully extracted and the overall contrast of the final fused image will not be decreased. Experimental results demonstrate the superiority of the proposed method.

3 | CONCLUSION

The articles presented in this special issue provide insights into fields related to Industrial and Medical Applications using Computational Intelligence Techniques, including models, performance evaluation and improvements, and application developments. We wish the readers can benefit from insights of these articles and contribute to these rapidly growing areas. We also hope that this special issue would shed light on major developments in the area of *Concurrency and Computation: Practice and Experience* and attract attention by the scientific community to pursue further investigations leading to the rapid implementation of these technologies.

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REFERENCES

1. Pavan PJ, Lorenzoni RK, Machado VR, Bez JL, et al. Energy efficiency and I/O performance of low-power architectures. *Concurr Comput Pract Exp*. 2019;31(18):e4948.
2. Chen J, Yu J, Qian Y, Li P, Bian C. A novel recommender algorithm based on graph embedding and diffusion sampling. *Concurr Comput Pract Exp*. 2020;32:e5664. https://doi.org/10.1002/cpe.5664.
3. Nasciutti TC, Panetta J, Lopes PP. Evaluating optimizations that reduce global memory accesses of stencil computations in GPGPUs. *Concurr Comput Pract Exp*. 2019;31(18):e4929.
4. Jeyaraj R, Ananthanarayana VS, Paul A. Improving MapReduce scheduler for heterogeneous workloads in a heterogeneous environment. *Concurr Comput Pract Exp*. 2020;32:e5558. https://doi.org/10.1002/cpe.5558.
5. Arumugam M, Sangaiah AK. Arrhythmia identification and classification using wavelet centered methodology in ECG signals. *Concurr Comput Pract Exp*. 2020;32:e5553. https://doi.org/10.1002/cpe.5553.
6. Rouberte L, Sena AC, Nery AS, Marzulo LAJ, Alves TAO, França FMG. DF-DTM: dynamic task Memoization and reuse in dataflow. *Concurr Comput Pract Exp*. 2019;31(18):e4937.
7. Jeon G. Structure and gradient-based industrial interpolation using computational intelligence. *Concurr Comput Pract Exp*. 2020;32:e5439. https://doi.org/10.1002/cpe.5439.
8. Liu F, Chen L, Lu L, Ahmad A, Jeon G, Yang X. Medical image fusion method by using Laplacian pyramid and convolutional sparse representation. *Concurr Comput Pract Exp*. 2020;32:e5632. https://doi.org/10.1002/cpe.5632.