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Computational Intelligence Techniques for Mobile Network Optimization

Modern society has become increasingly reliant on mobile networks for their communication needs. Such networks are characterized by their dynamic, heterogeneous, complex, and data intensive nature, which makes them more amenable to automated mobile network optimization performed using “computational intelligence” (CI) techniques rather than traditional optimization approaches. CI techniques—which subsume multidisciplinary techniques from machine learning (ML), optimization theory, game theory, control theory, and meta-heuristics—have a rich history in terms of being deployed in networking.

CI techniques are highly suited to the mobile networking architectures and the dynamic environments they characterize. Looking ahead, it looks likely that CI will play a leading role in upcoming 5th generation (5G) wireless mobile networks for developing optimized solutions for vexing problems—such as traffic scheduling and routing, capacity, coverage, and power optimization—in the face of stringent requirements and highly dynamic conditions.

The importance of our proposed theme of mobile network optimization (MNO) motivated us to propose this special issue in the IEEE Computational Intelligence Magazine (CIM)—the premier IEEE magazine for professionals

interested in CI techniques and their applications. We were successful in attracting several high-quality submissions (fourteen submissions in total). All of the submitted papers were reviewed by at least three competent independent referees and also by one editor. After a rigorous peer review process, we finally selected three papers as part of our special issue. These papers are described below.

In the first paper, “*Machine Learning for Performance Prediction in Mobile Cellular Networks*”, Riihijärvi and Mähönen present a case study of how machine learning can be used to predict performance of mobile cellular networks at locations, times, and for metrics for which direct measurements are not available. The authors propose using various ML and CI techniques for the task of temporal, spatial, and multidimensional prediction (including Gaussian process regression, exponential smoothing of time series, and random forests) in mobile cellular networks. The authors establish the viability and the promise of their proposed techniques using extensive real-world drive test data.

The paper “*Cluster-based Content Distribution Integrating LTE and IEEE 802.11p with Fuzzy Logic and Q-learning*” by Wu et al. focuses on using CI techniques (Q-learning and fuzzy logic based algorithms) for integrating the mobile cellular LTE service with the IEEE 802.11p standard that works in vehicular ad-hoc networking (VANET) environments. The authors propose a clustering based content distribution approach that

improves the performance of LTE and IEEE 802.11p point solutions by successfully performing resource pooling of two disparate technologies (LTE and 802.11p), using CI techniques.

Finally, the paper “*A Fast, Adaptive, Energy-Efficient Data Collection Protocol in Multi-Channel-Multi-Path Wireless Sensor Networks*” by Liew et al. proposes an adaptive energy-efficient scheduling solution for multi-channel wireless sensor networks (WSNs). The authors propose a two-phase approach in which node-channel assignment is performed using a graph-coloring approach in the first phase, and scheduling is performed in the second phase using a three-dimensional parallel iterative matching (3DPIM) approach. The authors demonstrate superior simulation results compared to traditional approaches and show their solution is able to perform fast and energy-efficient data collection while remaining responsive to network conditions.

We sincerely thank all of the authors who submitted their papers to our special issue, and to the large number of distinguished reviewers who volunteered their time and expertise and helped us in curating a high-quality special issue on this important and timely topic. We will also like to thank Prof. Hisao Ishibuchi, the Editor-in-Chief of IEEE Computational Intelligence Magazine (IEEE CIM), and other staff members of IEEE CIM for their continuous support and guidance, which made this special issue possible.