MANY OBJECTIVE EVOLUTIONARY OPTIMIZATION AND ITS APPLICATION IN CONVOLUTIONAL NEURAL NETWORK DESIGN AND DEPLOYMENT

Gary G. Yen, Regents Professor, FIEEE, FIET
Oklahoma State University
School of Electrical and Computer Engineering

Evolutionary computation is a branch of studying biologically motivated computational paradigms which exert novel ideas and inspiration from natural evolution and adaptation. The applications of population-based meta-heuristics in solving multiobjective optimization problems have been receiving a growing attention. To search for a family of Pareto optimal solutions based on nature-inspiring metaphors, Evolutionary Multiobjective Optimization Algorithms have been successfully exploited to solve optimization problems in which the fitness measures and even constraints are uncertain and changed over time. When encounter optimization problems with many objectives, nearly all designs perform poorly because of loss of selection pressure in fitness evaluation solely based upon Pareto optimality principle. During the last years, evolutionary algorithms have been adapted to address these challenges of curse of dimensionality. In addition, a minimum Manhattan distance (MMD) approach to multiple criteria decision making in many-objective optimization problems is proposed. This procedure is equivalent to the knee selection described by a divide and conquer approach that involves iterations of pairwise comparisons. Given such a directive, knee-based evolutionary algorithms have also been exploited to address dynamic optimization, constraint optimization, robust optimization and their applications including automatic design of the deep neural networks.

Specifically, we propose to automatically evolve CNN architectures by using a genetic algorithm (GA) based on ResNet and DenseNet blocks. Neither preprocessing before it starts nor postprocessing in terms of CNNs is needed. Furthermore, the proposed algorithm does not require users with domain knowledge on CNNs, the investigated problem, or even GAs. In addition to design CNNs, we will also discuss issues involved in deploying such CNNs. We formally establish filter pruning as a multiobjective optimization problem, and propose a knee-guided evolutionary algorithm that can automatically search for the solution with quality tradeoff between the scale of parameters and performance, in which both conflicting objectives can be optimized simultaneously. The proposed design and deployment algorithm is evaluated on the CIFAR10, CIFAR100 and ImagetNet benchmark data sets against 18 state-of-the-art peer competitors. Experimental results show that the proposed algorithm outperforms the state-of-the-art CNNs hand-crafted and the CNNs designed by automatic peer competitors in terms of the classification performance and achieves a competitive classification accuracy against semiautomatic peer competitors.

Biography

Gary G. Yen received the Ph.D. degree in electrical and computer engineering from the University of Notre Dame in 1992. He is currently a Regents Professor in the School of Electrical and Computer Engineering, Oklahoma State University. His research interest includes intelligent control, computational intelligence, evolutionary multiobjective optimization, conditional health monitoring, signal processing and their industrial/defense

applications.

Gary was an associate editor of the *IEEE Transactions on Neural Networks* and *IEEE Control Systems Magazine* during 1994-1999, and of the *IEEE Transactions on Control Systems Technology*, *IEEE Transactions on Systems, Man and Cybernetics* (Parts A and B) and IFAC Journal on *Automatica* and *Mechatronics* during 2000-2010. He is currently serving as an associate editor for the *IEEE Transactions on Evolutionary Computation*, *IEEE Transactions on Cybernetics* and *IEEE Transactions on Emerging Topics on Computational Intelligence*. Gary served as Vice President for the Technical Activities, IEEE Computational Intelligence Society in 2004-2005 and was the founding editor-in-chief of the *IEEE Computational Intelligence Magazine*, 2006-2009. He was the President of the IEEE Computational Intelligence Society in 2010-2011 and is elected as a Distinguished Lecturer for the term 2012-2014 and 2016-2018. He received Regents Distinguished Research Award from OSU in 2009, 2011 Andrew P Sage Best Transactions Paper award from IEEE Systems, Man and Cybernetics Society, 2013 Meritorious Service award from IEEE Computational Intelligence Society and 2014 Lockheed Martin Aeronautics Excellence Teaching award. He is a Fellow of IEEE and IET.