Department of Computer Science
香港城市大學
City University of Hong Kong

COMPUTER SCIENCE COLLOQUIUM

Adaptive Solution Prediction via Machine Learning for Large-Scale Combinatorial Optimization

SPEAKER **Professor Xiaodong Li**

Professor
School of Computing Technologies
RMIT University, Melbourne, Australia

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ABSTRACT

In the big data era, we frequently encounter combinatorial optimization problems of very high dimensionalities. The number of decision variables often exceed thousands or even millions. This poses significant challenges to standard solution techniques such as exact methods (e.g., CPLEX and Gurobi) and meta-heuristics (e.g., evolutionary algorithms), which are usually ill-equipped to cope with the sheer size of such large-scale problems. Meanwhile, machine learning has become increasingly popular as a viable technique to learn and discover problem structure, thereby providing a way moving forward to harness such knowledge for problem decomposition or reduction. The core idea is that if we can decompose a large-scale problem or reduce its size, then it may become plausible again to apply these existing methods. In this talk, I will present our work on "solution prediction via machine learning" for problem reduction, using machine learning models to learn from previously solved problem instances. Furthermore, we use what is learnt from our trained machine learning model to predict whether a decision variable belongs to an optimal solution on unseen and much larger problem instances. Our "solution prediction via machine learning" approach can be used as a generic pre-processing step to substantially prune the search space of a large-scale combinatorial optimization problem. Once the problem is reduced in size, we can then apply standard solution techniques, which hopefully become effective again. We have demonstrated the efficacy of our method for problem reduction over several classic combinatorial optimization problems such as Maximum Weight Clique Problems (MWCP) [1], Travelling Salesman Problems (TSP) [2][3], and Graph Colouring Problems (GCP) [4][5]. Our recent efforts have been to make such solution prediction methods more adaptive [6], to allow continuous refinement on the accuracy of the statistical features involved. As a result, the quality of prediction of our off-line trained machine learning model can be further improved.

BIOGRAPHY

Xiaodong Li received his bachelor's degree from Xidian University, Xi'an, China, and PhD in Artificial Intelligence from University of Otago, Dunedin, New Zealand, respectively. He is a Professor in Artificial Intelligence currently with the School of Computing Technologies, RMIT University, Melbourne, Australia. His research interests include machine learning, evolutionary computation, data mining/analytics, multiobjective optimization, multimodal optimization, large-scale optimization, deep learning, math-heuristic methods, and swarm intelligence. He served as an Associate Editor of journals including IEEE Transactions on Evolutionary Computation, Swarm Intelligence (Springer), and International Journal of Swarm Intelligence Research. He is a founding member of IEEE CIS Task Force on Swarm Intelligence, a former vice-chair of IEEE Task Force on Multi-modal Optimization, and a former chair of IEEE CIS Task Force on Large Scale Global Optimization. He is the recipient of 2013 ACM SIGEVO Impact Award and 2017 IEEE CIS "IEEE Transactions on Evolutionary Computation Outstanding Paper Award". His h-index is 60, with a total number of citations 15000+ (according to Google Scholar). He is an IEEE Fellow. He is the general chair for the upcoming GECCO2024, which will be held in Melbourne, Australia, from 14 – 18 July 2024.

All are welcome!

In case of questions, please contact Prof Zhang Qingfu at qingfu.zhang@cityu.edu.hk, or visit the CS Departmental Seminar Web at https://www.cs.cityu.edu.hk/events/cs-seminars/recent-cs-colloquiums.