EPSTEIN INSTITUTE SEMINAR ▪ ISE 651

Scale up Constrained Continuous Optimization with First-Order Methods

ABSTRACT: In this talk, I will talk about the recent ongoing trend of research on new first-order methods for scaling up constrained continuous optimization. Continuous constrained optimization, including linear programming (LP), quadratic programming (QP), second-order cone programming (SOCP), semi-definite programming (SDP), and nonlinear programming (NLP), is a fundamental tool in operations research with wide applications in practice. The state-of-the-art solvers for constrained continuous optimization are essentially based on either active-set (simplex) method or barrier method, which are quite mature and reliable at delivering highly accurate solutions. However, these methods do not scale up with modern computational resources, i.e., distributed computing and/or GPUs, and thus are not suitable for the big data era. The computational bottleneck of both methods is the matrix factorization when solving linear equations, which usually requires significantly more memory usage and cannot be directly applied with modern computing resources. In contrast, firstorder methods (FOMs) only require matrix-vector multiplications, which work very well on these modern computing infrastructures and have massively accelerated the machine learning training process during the last 15 years. The goal of this ongoing line of research is to scale up constrained continuous optimization 1000 times by using FOMs and taking advantage of modern computing resources. With an example of LP, I'll discuss how we are able to achieve this by explaining: (i) the intuitions about designing an FOM for LP; (ii) theoretical results, including complexity theory, infeasibility detection, condition number theory, and how theory can lead to better computation and better understanding of the algorithm's performance; (iii) numerical results of the proposed algorithm on large instances and modern computing architectures; (iv) large-scale applications on personalized marketing. If time permits, I'll also talk about our recent results on QP. I'll conclude the talk with open questions and new directions on this line of research.

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SPEAKER BIO – Haihao (Sean) Lu is an assistant professor of Operations Management at the University of Chicago Booth School of Business. His research interests are in extending the computational and mathematical boundaries of methods for solving the large-scale optimization problems that arise in data science, machine learning, and operations research. Before joining Booth, he was a visiting researcher at Google Research large-scale optimization team, where he primarily worked on designing and implementing a huge-scale linear programming solver. He obtained his Ph.D degree in Operations Research and Mathematics at MIT in 2019. His research has been recognized by many research awards, including is INFORMS Optimization Society Young Researcher Prize, Michael H. Rothkopf Junior Researcher Paper Prize (first place), and INFORMS Revenue Management and Pricing Section Prize.

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