Optimization Methods and Software

ISSN: 1055-6788 (Print) 1029-4937 (Online) Journal homepage: www.tandfonline.com/journals/goms20

Preface for the special issue advances in distributed optimization

Alexander Gasnikov & Angelia Nedich

To cite this article: Alexander Gasnikov & Angelia Nedich (2025) Preface for the special issue advances in distributed optimization, Optimization Methods and Software, 40:5, 1015-1016, DOI: 10.1080/10556788.2025.2555028

To link to this article: https://doi.org/10.1080/10556788.2025.2555028

OPTIMIZATION METHODS & SOFTWARE
2025, VOL. 40, NO. 5, 1015–1016
https://doi.org/10.1080/10556788.2025.2555028

Taylor & Francis
Taylor & Francis Group

INTRODUCTION

Preface for the special issue advances in distributed optimization

Alexander Gasnikov [a] and Angelia Nedich[b]

[a]Moscow Institute of Physics and Technology, Innopolis University, Innopolis city, Tatarstan republic, Russian Federation; [b]School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA

Distributed and decentralized optimization has been actively developing since the 1980s. Overall, until the early 2010s, this development progressed rather steadily. However, recently, due to the vast number of applications in data analysis (artificial intelligence) and the inability to load (store) all training data on a single device, distributed optimization has experienced a real boom. In addition to classical formulations, areas such as decentralized optimization on time-varying graphs (networks), asynchronous optimization, federated learning, personalized federated learning, and distributed optimization with compressions (biased and unbiased), among others, have gained popularity. All these new problem formulations have been motivated by applications. Furthermore, not so long ago (ten years ago), the field of distributed optimization significantly lagged behind non-distributed optimization in theoretical sense, where in many important cases lower bounds on the number of oracle calls were obtained, and algorithms were proposed that operated according to these lower bounds. The difficulty arose from the fact that, unlike classical optimization, where the criterion is typically one—the number of oracle calls—additional criteria emerge for distributed optimization regarding the number of communication steps or, in general, the volume of transmitted information and the frequency of communications. With the introduction of two or more criteria, it seemed increasingly difficult to expect uniform optimality across all these criteria. Surprisingly, this is not only possible but also somewhat typical. The achievements of the last ten years demonstrate that the field of distributed optimization is surprisingly strong in theoretical terms. Just as in classical (non-distributed) optimization, it is possible to construct lower bounds that are uniform across all criteria and obtain algorithms that achieve them. Despite this optimism, due to the large influx of new problem formulations, including those mentioned above, many open problems remain where existing algorithms and existing lower bounds (if any) do not correspond to each other—meaning there is a gap, or worse yet, no lower bounds exist.

This Special Issue aims to reduce the number of such open problem formulations and, in some cases, to narrow the gap between lower bounds and upper bounds. The Special Issue is distinguished by three main aspects: (1) almost all articles have a pronounced theoretical character and well demonstrate the high mathematical standard currently present in this field; (2) nearly all articles address new relevant problem formulations motivated by specific

CONTACT Alexander Gasnikov gasnikov@yandex.ru

applications, typically related to distributed learning of large models; (3) all articles feature well-known specialists as co-authors who have achieved foundational results in distributed optimization.

Given all this, we believe that this Special Issue will be of interest to a wide range of specialists in numerical methods for optimization and their applications.

This Special Issue is dedicated in memory of Oleg P. Burdakov, Boris T. Polyak, and Fyodor P. Vasilyev.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes on contributors

Alexander Gasnikov got his B.Sc. and M.Sc. degrees from the Faculty of Control and Applied Mathematics of Moscow Institute of Physics and Technology in 2004 and 2006, respectively. He obtained a PhD from the same university in 2007 and a Doctor's degree (Habilitation) in 2016 (supervised by A. Shananin and Yu. Nesterov). Since 2020, he has been a professor at the Moscow Institute of Physics and Technology and the High School of Economics. Since 2022, he has been the head of the Laboratory Mathematical Methods of Optimization and head of the department Mathematical Foundations of Control. Since 2023, he has been the rector of Innopolis University. He has Yahoo, Yandex, the Moscow government and Huawei awards. Alexander is the author of more than 200 papers, including papers in Q1 journals (OMS, JOTA, SIAM, EJOR e.t.c.) and A* conferences (NeurIPS, ICML, COLT).

Angelia Nedich holds a PhD from Moscow State University, Moscow, Russia, in Computational Mathematics and Mathematical Physics (1994), and a PhD from Massachusetts Institute of Technology, Cambridge, USA, in Electrical and Computer Science Engineering (2002). She has worked as a senior engineer in BAE Systems North America, Advanced Information Technology Division at Burlington, MA. She is the recipient of an NSF CAREER Award in 2007 in Operations Research for her work in distributed multi-agent optimization. She is a recipient (jointly with her co-authors) of the Best Paper Award at the Winter Simulation Conference 2013 and the Best Paper Award at the International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt) 2015. Also, she is a coauthor of the book Convex Analysis and Optimization. Her current interest is in large-scale optimization, games, control and information processing in networks.

ORCID

Alexander Gasnikov http://orcid.org/0000-0002-7386-039X