

AFRL-AFOSR-VA-TR-2019-0346

Mechanism Design for Complex Systems: A Black-box Model Approach

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10/04/2019 Final Report

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Final Report: Mechanism Design for Complex Systems: A Black-box Model Approach

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Program:	Discrete Mathematics and Optimization
Grant:	15RT0767
Reporting Period:	September 30, 2016 - September 30, 2019

1 Introduction

This is the final report on the AFOSR project, "Mechanism Design for Complex Systems: A Blackbox Model Approach", which was carried out at by A. Garcia (currently at Texas A&M University) and Mingyi Hong (currently at IU. of Minnesota). The present final report covers the period September 30, 2016 to September 29, 2019.

1.1 Summary of Research Activities

In this project we study solution methods for distributed optimization problems over a multi-agent network, where each agent can only partially evaluate the objective function, and it is allowed to exchange messages with its immediate neighbors. Differently from all existing works on distributed optimization, our focus is given to optimizing a class of difficult non-convex problems, and under the challenging setting where each agent can only access the zeroth-order information (i.e., the functional values) of its local functions (this is also often referred to as black-box model). We consider two generic settings: in the first, we assume agents in the network truthfully exchange information with neighbors. In the second setting, we relax this assumption thus turning the problem into a mechanism design problem requiring the design of incentives for truthful information reporting.

2 Products

In this section, we list the main products generated by this project.

- "Zeroth Order Nonconvex Multi-Agent Optimization over Networks" (2019) D. Hajinezhad, M. Hong and A. Garcia, **IEEE Transactions on Automatic Control**, Vol. 64 No. 10, pp. 3995-4010
- 2. "Swarming for Faster Convergence in Stochastic Optimization" (2018) S. Pu and A. Garcia, **SIAM Journal on Control and Optimization**, Vol. 56 No. 4, pp. 2997-3020.
- 3. W.-C. Liao, M. Hong, H. Farmanbar, and Z.-Q. Luo, "A Distributed Semi-Asynchronous Algorithm for Network Traffic Engineering", **IEEE Transactions on Signal and Information Processing over Networks**, Volume: 4, Issue: 3, Sept. 2018)
- 4. "A Flocking-based Approach for Distributed Stochastic Optimization" (2017) S. Pu and A. Garcia, **Operations Research**, Vol 6, pp. 267-281
- 5. "Prox-PDA: The Proximal Primal-Dual Algorithm for Fast Distributed Nonconvex Optimization and Learning Over Networks", M. Hong, D. Hajinezhad, M.-M. Zhao, Proc. International Conference on Machine Learning (ICML) 2017
- 6. D. Hajinezhad, M. Hong, T. Zhao, and Z. Wang, "NESTT: A nonconvex primal-dual splitting method for distributed and stochastic optimization," in **Proceedings of Neural Information Processing** (NIPS), 2016
- 7. P. Shi, A. Garcia and Z. Lin "Noise Reduction by Swarming in Social Foraging", IEEE Transactions on Automatic Control, (2016) Vol. 61, No. 12 pp. 4007-4013.

3 Students Funded

This project has partially supported the following graduate students

- 1. Pu Sun, graduated in 2017 (PhD).
- 2. Davood Hajinezhad, graduated in 2018 (PhD).
- 3. Luochao Wang, 2019 (M.Sc.)
- 4. Songtao Lu, graduated in 2019 (PhD)

4 Other Activities Supported

This project has supported the following activities

- Travel of both PIs to attend the annual review meetings held at Arlington VA.
- Travel of both PIs and students to present research funded by this project at INFORMS (2016, 2018) and IEEE CDC (2017, 2018), ISMP (2018), DIMACS Workshop on Distributed Optimization, Information Processing, and Learning, New Brunswick, NJ, 2017
- Summer support for both PIs.