



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

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10/04/2019
Final Report

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Air Force Research Laboratory
AF Office Of Scientific Research (AFOSR)/ RTA2
Arlington, Virginia 22203
Air Force Materiel Command

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REPORT DOCUMENTATION PAGE				<i>Form Approved</i> OMB No. 0704-0188	
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1. REPORT DATE (DD-MM-YYYY) 11-11-2019		2. REPORT TYPE Final Performance		3. DATES COVERED (From - To) 30 Sep 2015 to 29 Sep 2019	
4. TITLE AND SUBTITLE Mechanism Design for Complex Systems: A Black-box Model Approach				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER FA9550-15-1-0504	
				5c. PROGRAM ELEMENT NUMBER 61102F	
6. AUTHOR(S) Panagote Pardalos, Alfredo Garcia				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) UNIVERSITY OF FLORIDA 207 GRINTER HALL GAINESVILLE, FL 32611-5500 US				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AF Office of Scientific Research 875 N. Randolph St. Room 3112 Arlington, VA 22203				10. SPONSOR/MONITOR'S ACRONYM(S) AFRL/AFOSR RTA2	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-AFOSR-VA-TR-2019-0346	
12. DISTRIBUTION/AVAILABILITY STATEMENT A DISTRIBUTION UNLIMITED: PB Public Release					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT 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.					
15. SUBJECT TERMS Black-box Model Approach, Complex Systems, Mechanism Design					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON FAHROO, FARIBA
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) 703-696-8429

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

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Agency: Air Force Office of Scientific Research (AFOSR)

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 Black-box 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.

1. “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.