COST
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SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: CA16228 European Network for Game Theory
STSM title: Accelerating Hessian-barrier algorithm
STSM start and end date: 08/10/2018 to 12/10/2018
Grantee name: Pavel Dvurechensky

PURPOSE OF THE STSM/

The Hessian-barrier algorithm (HBA) has been recently introduced by Bomze, Mertikopolous, Schachinger and Staudigl as general framework to construct first-order methods for non-convex optimization with linear constraints. The advantage of working with this system is to get rid of the projection step in conventional Bregman proximal solvers. As a special case all payoff-monotone game dynamics for potential games in discrete time can be analyzed in a single unified setting. In another recent paper by Haeser, Liu and Ye, a potential reduction method was proposed for non-convex linearly constrained problem over a non-negative orthant. The purpose of the STSM was to introduce a unified framework, which covers both the HBA algorithm and the potential reduction method.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

The proof techniques of the work by Haeser, Liu and Ye were understood with the potential extension to cover also the HBA algorithm. Numerous discussions of this extension were held. Additionally possible application of Nesterov's acceleration to the HBA algorithm was discussed and an important question of feasibility of the iterates of the accelerated method in the setting of minimization of a self-concordant barrier was raised. Also an extension of these algorithms for stochastic optimization problems was discussed.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

A new problem setting was proposed, which generalizes the problem in the works by Bomze, Mertikopolous, Schachinger and Staudigl, and Haeser, Liu and Ye. Namely, the new problem is to minimize a non-convex smooth function over a set given by intersection of a *convex set given by a self-concordant barrier* and a linear subspace. New first-order and second-order schemes were proposed. As opposed to Haeser, Liu and Ye, these schemes use regularized Taylor expansion instead of a trust region step. A sketch of the convergence rate proof is written for the first-order scheme.

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FUTURE COLLABORATIONS (if applicable)

It is planned to continue to work on a joint paper with first- and second-order scheme. For the second-order scheme, the analysis of the cubic regularized Newton method of Nesterov and Polyak will be extended for the case of linearly constrained problems. The possibility of acceleration will be further investigated as well as an extension for stochastic optimization problems. Machine learning applications for models including self-concordant loss and a regularizer are also anticipated.