XIV BRAZILIAN WORKSHOP ON CONTINUOUS OPTIMIZATION

NOTEBOOK OF ABSTRACTS

AND

OTHER RELEVANT INFORMATION

School of Applied Mathematics of Fundação Getúlio Vargas, Rio de Janeiro, Brazil

investigation, we present several innovative properties of the intrinsic κ-projection into convex sets of κ-hyperbolic space forms. These properties are crucial for analyzing the method and also hold independent significance. We discuss the relationship between the intrinsic κ-projection and the Euclidean orthogonal projection, as well as the Lorentz projection. Moreover, we provide formulas for the intrinsic κ-projection into specific convex sets, using the Euclidean orthogonal projection and the Lorentz projection. Regarding the convergence results of the gradient projection method, we establish two main findings. Firstly, we demonstrate that every accumulation point of the sequence generated by the method with backtracking step sizes is a stationary point for the given problem. Secondly, assuming the Lipschitz continuity of the gradient of the objective function, we show that each accumulation point of the sequence generated by the gradient projection method with a constant step size is also a stationary point. Additionally, we provide an iteration complexity bound that characterizes the number of iterations needed to achieve a suitable measure of stationarity for both step sizes. Finally, we explore the properties of the constrained Fermat-Weber problem, demonstrating that the sequence generated by the gradient projection method converges to its unique solution.

Numerical studies on continuous approximations of a cone in an augmented Lagrangian method for nonlinear conic optimization

Mituhiro Fukuda[1], Walter Gómez[2], Gabriel Haeser[3] and Leonardo M. Mito[3]

1 Federal University of ABC, Brazil, e-mail: mituhiro.f@ufabc.edu.br
2 Universidad de la Frontera, Chile, e-mail: walter.gomez@ufrontera.cl
3 University of São Paulo, Brazil, e-mails: ghaeser@ime.usp.br, leonardommito@gmail.com

Keywords: nonlinear conic optimization, augmented Lagrangian method, copositive programming

Abstract

We are interested in practically solving a nonlinear conic programming (NCP) problem stated as

$$(NCP) \quad \begin{cases} \text{minimize} & f(x) \\ \text{subject to} & g(x) \in \mathrm{K} \end{cases}$$

where $f: R^n \to R$ and $g: R^n \to E$ are continuously differentiable functions, E is a finite-dimensional vector space with an inner product, and $K \subseteq E$ is a closed convex cone. Particular cases when $f(x)$ and $g(x)$ are convex functions and K is the semidefinite symmetric matrix cone or the second-order cone can be solved efficiently [1, 4]; or when $f(x)$ is a linear function and K is the copositive cone has a better treatment [3]. Recently, Andreani et al. [2] extended a sequential optimality condition from nonlinear programming [5] to the NCP. In this study, we propose a variant of these methods, which satisfies these conditions based on an augmented Lagrangian method with continuous approximations of K. In particular, we consider an implementation with a polyhedral approximation K^k of the copositive cone K, which compensates the numerous expensive projection onto K^k per iteration required by these methods. Numerical results confirm our finding on some small examples.

Bibliography
[1] M. Andersen, J. Dahl and L. Vandenberghe. CVXOPT: Python software for convex optmization, https://cvxopt.org/index.html.
[2] R. Andreani, W. Gómez, G. Haeser, L.M. Mito, and A. Ramos. On optimality conditions for nonlinear conic programming. Mathematics of Operations Research, 47(3), 2160-2185, 2022.
[3] M. Dür and F. Rendl. Conic optimization: A survey with special focus on copositive optimization and binary quadratic problems. EURO Journal on Computational Optimization, 9, 100021, 2021.
[4] M. Kocvara and M. Stingl. PENNON: A code for convex nonlinear and semidefinite programming. Optimization methods and software, 18(3), 317-333, 2003.
[5] J.M. Martínez and B.F. Svaiter. A practical optimality condition without constraint qualifications for nonlinear programming. Journal of Optimization Theory and Applications, 118, 117-133, 2003.

A multicut approach to compute upper bounds for risk-averse SDDP

Joaquim Dias Garcia, Iago Leal, Raphael Chabar and Mario Veiga Pereira

PSR, Brazil, {joaquim, chabar, mario}@psr-inc.com, iago.lealf@gmail.com

Keywords: SDDP, CVaR, Multicut, Brazil, Power Systems, Risk

Abstract

Stochastic Dual Dynamic Programming (SDDP) is a widely used and fundamental algorithm for solving multistage stochastic optimization problems. Although SDDP has been frequently applied to solve risk-averse models with the Conditional Value-at-Risk (CVaR), it is known that the estimation of upper bounds is a methodological challenge, and many methods are computationally intensive. In practice, this leaves most SDDP implementations without a practical and clear stopping criterion. In this paper, we propose using the information already contained in a multicut formulation of SDDP to solve this problem with a simple and computationally efficient methodology. The multicut version of SDDP, in contrast with the typical average cut, preserves the information about which scenarios give rise to the worst costs, thus contributing to the CVaR value. We use this fact to modify the standard sampling method on the forward step so the average of multiple paths approximates the nested CVaR cost. We highlight that minimal changes are required in the SDDP algorithm and there is no additional computational burden for a fixed number of iterations. We present multiple case studies to empirically demonstrate the effectiveness of the method. First, we use a small hydrothermal dispatch test case, in which we can write the deterministic equivalent of the entire scenario tree to show that the method perfectly computes the correct objective values. Then, we present results using a standard approximation of the Brazilian operation problem and a real hydrothermal dispatch case based on data from Colombia. Our numerical experiments showed that this method consistently calculates upper bounds higher than lower bounds for those risk-averse problems and that lower bounds are improved thanks to the better exploration of the scenarios tree.