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Inner Moreau Envelope of Nonsmooth Conic Constrained Probability Functions

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Optimization problems involving uncertainty in the constraints arise in a wide range of applications. A natural framework for handling such uncertainty is through probability functions. However, these functions are often nonsmooth, which poses challenges for both analysis and computation. In this talk, we propose a regularization approach based on the Moreau envelope applied to a scalarization of the underlying vector inequality constraint. Specifically, we study a broad class of probability functions that encompasses many common forms of probabilistic constraints, where the inner constraint is expressed in a nonlinear conic form.

Our regularization method applies the Moreau envelope to a scalar representation of the data, yielding a smooth approximation of the original nonsmooth probability function. Under mild assumptions, we establish the smoothness of the regularized function and prove a form of variational convergence to the original probability function. As a result, for suitably structured optimization problems with probabilistic constraints, we can ensure that the minimizers of the regularized problems converge to those of the original problem.

We conclude by presenting illustrative examples and applications, including nonsmooth joint chance constraints, semidefinite chance constraints, and probust optimization problems.

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