Master MSIAM thesis project – Modeling and Scientific Computing (MSC) or Data Science (DS)

Title: optimization face to uncertainty on data

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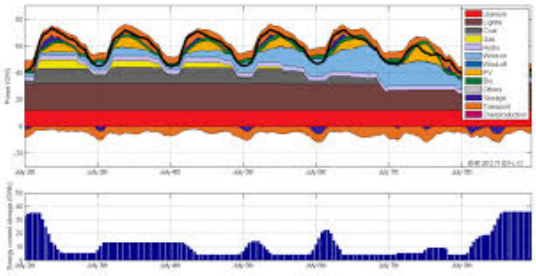
Context: Data uncertainty is an inherent feature of optimization problems and has to be taken into account in optimization and decision-making tools. Uncertainty can come from noisy data (e.g. high-volatility financial markets), unreliable data (e.g imprecise ratings in collaborative filtering), or uncertain predictions (e.g. different scenarios in forecasting). A typical example is the recent trend in electricity generation: the growing incorporation of renewable energy sources (wind, solar) in the electricity park has dramatically increased the level of uncertainty when optimizing electricity generation [1].



The three main paradigms in optimization under uncertainty and decision-making problems face to uncertainty consist in using

– approximations of the expected value of uncertain variables (i.e., stochastic optimization),
– a worst case value over an uncertainty set (i.e., robust optimization [2]),
– probability constraints of the form $\mathbb{P}\big(g(x,\xi) \geqslant 0\big) \leqslant \varepsilon$.

Though attractive in theory, the third one is much less developed because of two numerical drawbacks: 1) the probability constraints are not necesserily convex; 2) approximating the value of the probability function (and its gradients or hessians when they exist [3]) involves noisy computations [5].

Objectives: This master thesis will consider theoretical and algorithmic questions in the above-descrided broad topic. Special interest will be to given to design efficient algorithms to treat the nonconvex noisy probability-constrained optimization problems by extending bundle-type methods of nonsmooth optimization [4]. We will have important applications in electricity optimization, as a target. The aim would be to have contributions on three aspects: mathematical properties, algorithmic developments, and application on real-life data.

Practical information:

– Working place: LJK (Grenoble) or EDF research Department (Saclay), depending on the student.
– Salary: the master student will get the usual salary and gratifications.
– This project opens up to (academic or industrial) PhD thesis.

Keywords: nonsmooth optimization, convex analysis, bundle methods, energy applications

References

[1] W. van Ackoiij and J. Malick, "Decomposition algorithm for large-scale two-stage unit-commitment," *To appear in Annals of Operations Research*, 2014.

[2] A. Ben-Tal, L. E. Ghaoui, and A. Nemirovski, *Robust Optimization*. Princeton University, 2011.

[3] W. van Ackoiij and J. Malick, "Second-order differentiability of probability functions," *Submitted to Optimization Letters*, 2015.

[4] J.-B. Hiriart-Urruty and C. Lemaréchal. *Convex Analysis and Minimization Algorithms*. Springer Verlag, 1993.

[5] A. Ruszczyński and A. Shapiro, *Stochastic Programming*, vol. 10 of *Handbooks in Operations Research and Management Science*. Elsevier, 2003.