NonSmoothFwdAD: A Julia package for nonsmooth differentiation

April 9 2023

Summary

Mathematically, non-smooth functions are those that are not infinitely continuously differentiable. Since classical optimization assumes certain differentiability conditions, it becomes impractical to apply to non-smooth optimization problems. It can often be infeasible to exhaust all potential solutions, especially given that discontinuities may produce multiple feasible regions. Non-smooth analysis techniques were designed to handle concerns surrounding differentiation and allow for applications of more classical optimizations (Khan and Barton 2015) Griewank (1994).

Statement of need

`NonSmoothFwdAD` is a Julia package implementing two recent methods for evaluating generalized derivatives of continous, non-smooth functions while retaining the beneficial properties of smooth function derivatives. The first being the vector forward mode of automatic differentiation for functions of finite compositions of simple "scientific calculator" operations. The second is the compass difference rule for bivariate scalar valued functions.

clearly illustrates the research purpose of the software and places it in the context of related work

Acknowledgements

References

Barton, Paul I., Kamil A. Khan, Peter Stechlinski, and Harry A. J. Watson. 2018. "Computationally Relevant Generalized Derivatives: Theory, Evaluation and Applications." *Optimization Methods and Software* 33 (4-6): 1030–72. https://doi.org/10.1080/10556788.2017.1374385.

Francisco Facchinei, Andreas Fischer, and Markus Herrich. 2014. "An LP-Newton Method: Nonsmooth Equations, KKT Systems, and Nonisolated Solutions." *Mathematical Programming* 146: 1–36. https://doi.org/10.1007/s10107-013-0676-6.

Griewank, Andreas. 1994. "Automatic Directional Differentiation of Nonsmooth Composite Functions." In *Recent Developments in Optimization, French-German Conference on Optimization.* Dijon.

Griewank, Andreas, and Andrea Walther. 2008. *Evaluating Derivatives.* Second. Society for Industrial; Applied Mathematics. https://doi.org/10.1137/1.9780898717761.

Khan, Kamil A., and Paul I. Barton. 2015. "A Vector Forward Mode of Automatic Differentiation for Generalized Derivative Evaluation." *Optimization Methods and Software* 30 (6): 1185–1212. https://doi.org/10.1080/10556788.2015.1025400.

Khan, Kamil A., and Yingwei Yuan. 2020. "Constructing a subgradient from directional derivatives for functions of two variables." *Journal of Nonsmooth Analysis and Optimization* Volume 1 (June). https://doi.org/10.46298/jnsao-2020-6061.

Nesterov, Yu. 2005. "Lexicographic Differentiation of Nonsmooth Functions." *Mathematical Programming* 104 (2-3): 669–700. https://doi.org/10.1007/s10107-005-0633-0.