High Order Taylor-like Expansions of Piecewise Smooth Functions and Their Application to DAEs

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Abstract: Computer algorithms or evaluation procedures of Piecewise smooth functions can be represented as a so called Abs-Normal Form (ANF). ANFs of piecewise smooth computer programs can be obtained quite naturally from automatic differentiation tools (e.g. Algopy, CodiPack, or Adol-C to name a few) and a allow a different treatment of the smooth parts and the non-smooth absolute value calls. In so doing high order piecewise polynomial approximations of ANFs can be propagated efficiently in a Taylor-like fashion.
This generalized expansion-process for functions in ANF representation is an extension of the so called tangent mode of piecewise linearisation, which was introduced in [1]. We will discuss the overall propagation process and how to extend the secant mode of piecewise linearisation in the same way by using Newton interpolations instead of Taylor expansions for the smooth parts.
Furthermore, we will present a framework for the construction of generalized integrators for ordinary differential equations and index 1 semi-explicit differential algebraic equations (DAE) in ANF representation, which treats occurring non-differentiable events without explicit detection.

References

[1] A. Griewank, On stable piecewise linearization and generalized algorithmic differentiation; Optimization Methods and Software, 2013

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