

PDAEs redux

Uri Ascher¹

Abstract: The search for effective numerical methods and software for solving systems of differential equations subject to algebraic constraints seemed to have peaked already during the 1990s, although interesting and important extensions and analysis have continued until present days. And yet, we have found ourselves recently re-examining older ideas and beliefs regarding some computational principles in the context of two different large applications.

One of these applications involves the simulation of friction and contact effects in the context of a deformable object motion that arises in computer graphics and robotics. The need to flexibly engage and disengage such constraints and the quest for a differentiable model lead one to introduce penalty and interior point methods, even at the price of some additional complexity and potential instability.

The other project investigates, in the context of machine learning and neural differential equations, different stabilization methods for differential equations with invariants which arise from the elimination of algebraic constraints.

References

- E. Larionov, A. Longva, U. Ascher, J. Bender and D. Pai (2022), arXiv2211.10618 : Fully implicit frictional dynamics with soft constraints
- T. Boesen, E. Haber and U. Ascher (2022), arXiv2211.14302: Neural DAEs: Constrained neural networks

¹ Department of Computer Science, University of BC, Vancouver, Canada
ascher@cs.ubc.ca