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Fast numeric geometric techniques for computer generated DAE models

This talk is the second of two talks in the session (the first being that of Greg Reid) which focuses on numeric-geometric algorithms for nonlinear systems of ODE with constraints.

Such so-called DAE arise frequently in applications, and are often so complicated that they are automatically generated by computer environments (in our case, the MapleSim environment). Missing constraints arising by prolongation (differentiation) of the DAE need to be determined to consistently initialize and stabilize their numerical solution. In this talk, we review a fast prolongation method to include constraints. Our symbolic-numeric method avoids the unstable eliminations of exact approaches. The method is successful provided the prolongations with respect to a single dominant independent variable have a block structure which is efficiently uncovered by Linear Programming.

Constrained mechanical systems generated by MapleSim are used to demonstrate the power of the approach. Using the fast prolongation method and block structure give us missing constraints and initial condition respectively for the system. Globally qualitatively distinct classes of solutions are determined by using Bertini software, whose approach is global homotopy continuation method based on numerical algebraic geometry. Finally, we built efficient interface to Maple's dsolve/numeric for these different models.