SEMINARIO

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Local behavior and propagation of errors for Taylor and Padé methods on stiff ODEs

Abstract: We explore the stiffness of ODEs using the Taylor method, exploiting its ability to achieve arbitrarily high orders and precision. The stepsize restrictions observed in practice are understood through the propagation of errors that the floating point arithmetic induces on the initial value of each step. To first order, this error is carried by the derivative of the method, and the notion of jet transport allows to identify it with the integration of the variational equations with the same method. Since these are linear and homogeneous, their study reduces to the linear stability of the method, at least near hyperbolic attracting fixed points and attracting slow manifolds.

We also study Padé methods built from the same jet of derivatives through the epsilon algorithm, for which a naive study of their (scalar) linear stability would suggest a much better behavior than the one they exhibit. These methods are not jet-compatible, and so what propagates the error term is the derivative of the method rather than the method applied to the derivative. Measuring this quantity, we can reproduce the stepsize restrictions observed in the numerical experiments and find that the moderate improvement over the Taylor method does not compensate for the additional cost of the epsilon algorithm.

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