

The joys and challenges of exponential integration

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Exponential integration has taken a more prominent role in scientific computing over the past decades. Exponential schemes offer computational savings for many problems involving large stiff systems of differential equations. Careful design of a practical exponential scheme is crucial, however, to ensure that the resulting method is efficient for a particular equation. In particular, to construct an efficient exponential scheme it is important to take into account what algorithms are used to approximate products of the exponential-like matrix functions of the problem's Jacobian or its approximations and vectors. We will discuss several ways to build classes of exponential integrators that take advantage of the structure of the numerical linear algebra algorithms employed within the time integration method. We will present fully exponential, partitioned and hybrid implicit-exponential schemes and illustrate performance of these methods using several application.

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