Multiple time stepping algorithms for explicit one-step exponential integrators

Rujeko Chinomona

February 26, 2018

1 Terms to understand

- Stiff ODEs - a stiff equation is a differential equation for which certain numerical methods for solving the equation are numerically unstable, unless the step size is taken to be extremely small.
  -An ordinary differential equation problem is stiff if the solution being sought is varying slowly, but there are nearby solutions that vary rapidly, so the numerical method must take small steps to obtain satisfactory results.

- Exponential integrators - a class of numerical methods for the solution of ordinary differential equations, specifically initial value problems. This large class of methods from numerical analysis is based on the exact integration of the linear part of the initial value problem. Because the linear part is integrated exactly, this can help to mitigate the stiffness of a differential equation.

- Rosenbrock methods - for stiff differential equations are a family of multistep methods for solving ordinary differential equations that contain a wide range of characteristic timescales.

- Exponential Runge-Kutta methods

2 Basics of Runge-Kutta methods

3 Layout of paper

3.1 Section 2: Derive exponential RK methods

3.2 Section 3: Derive MTS algorithms

3.2.1 For exponential quadrature rules

3.2.2 For exponential time differencing methods

3.2.3 For exponential Rosenbrock methods

3.3 Section 4: Stability

3.4 Section 5: Numerical Results