Convex Splitting Runge–Kutta methods for gradient flows

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ABSTRACT

We introduce Convex Splitting Runge–Kutta methods to solve the gradient flow considering the energy stability, which provide a simple unified framework. The core idea is the combination of convex splitting methods and multi-stage implicit-explicit Runge–Kutta methods. The proposed methods are high-order accurate in time. In addition, the energy stability is completely proved when we consider the special design of implicit-explicit Runge–Kutta tables, called a resemble condition. We present numerical experiments with the Cahn–Hilliard equation which is a typical example for the gradient flow to show the numerical accuracy, stability, and efficiency of the proposed methods.

REFERENCES