Self Starting General Linear Methods with Runge–Kutta Stability

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We have recently focused our attention on using general linear methods (GLMs) as a framework to analyze and generalize existing classes of numerical methods for ordinary differential equations. In particular, starting from Runge-Kutta methods, this approach can lead to the definition of Self Starting GLMs that are multi-stage multi-step methods, which do not require any additional starting procedure. We showed how some properties of Runge-Kutta methods can be improved, keeping similar computational costs. This analysis indicates that the proposed methods may have better accuracy and stability properties, such as, for example, larger stability regions in the case of explicit methods, or stage order greater than one for singly diagonally implicit methods. The possibility to identify good families of implicit and explicit methods with a larger number of free parameters allows the determination of new efficient and highly stable Implicit-Explicit (IMEX) methods.
Finally, we report numerical experiments which confirm that Self Starting (implicit, explicit and IMEX) GLMs are competitive and can have better performance than Runge-Kutta methods.

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