

Title: On numerical positivity and contractivity for Runge–Kutta methods

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Abstract:

For many problems, numerical preservation of positivity and contractivity are crucial issues for obtaining numerical solutions with physical sense. The Strong Stability Preserving (SSP) theory can be used to obtain time step restrictions to preserve these qualitative properties. However, it is well known that for many problems, the stepsize bounds obtained in this way are not sharp.

In order to obtain a better insight on the numerical preservation of contractivity and positivity, we study two linear problems that arise after a spatial discretization of the 1D diffusion problem. The simplicity of the problem allow us to obtain necessary and sufficient conditions for any value of the spatial discretization parameter, both for numerical positivity and contractivity. The analysis done shows the relationship between these qualitative properties and allows a comparison with the stepsize restrictions obtained with the SSP theory.

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