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High order semi-implicit numerical schemes for some level set equations

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In this talk, we present a class of high-order upwind based semi-implicit schemes for the numerical solution of some level set equations. The schemes are unconditionally stable and they are derived using the approach presented in [1]. The discrete linear systems after discretization and linearization have a convenient form that can be exploited for their efficient solution using, e.g., fast sweeping methods [2]. The method is applied to an advective (in general nonlinear) level set equation to describe implicitly the movement of an interface. The main application is a pore geometry evolution in flow and transport problems in porous media [3, 4].

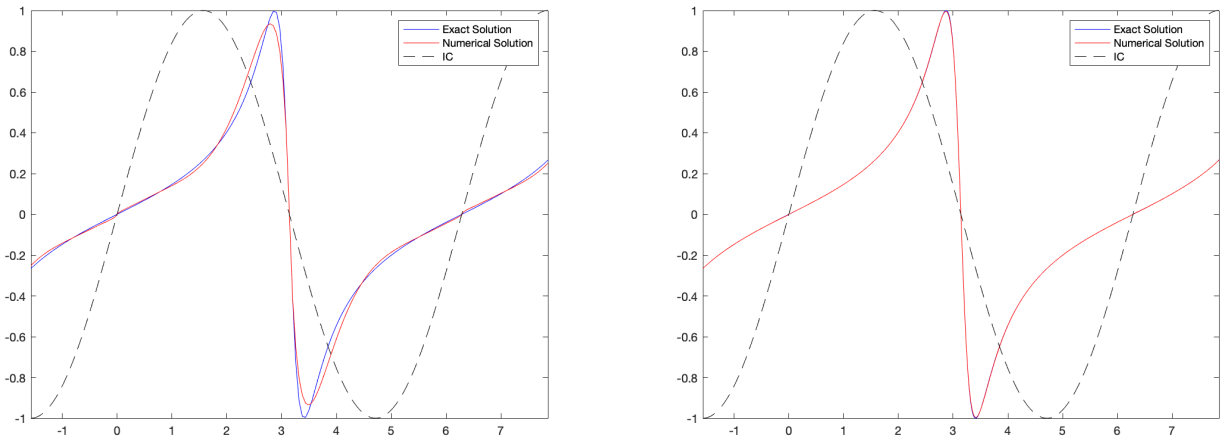

Figure 1: The initial condition (the dashed black line) and the numerical (the red bold line) and exact solution (the blue bold line) at final time for a nonconservative advection equation with variable velocity equals to $sin(x)$. The results on the left are obtained with one time step having maximal Courant number equals approximately 34 and $h = 3\pi/160$ and the results on the right with four time steps and $h = 3\pi/640$. The global error in time and space decreases with each uniform grid refinement for the same Courant number with the factors 6.8, 7.6, and 8.1 showing clearly the third order accuracy of the scheme.

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