Matrix equation techniques for time-dependent partial differential equations

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In this talk we show how the linear system stemming from the all-at-once approach for the heat equation can be recast in terms of a Sylvester matrix equation which naturally encodes the separability of the time and space derivatives. Combining timely projection techniques for the space operator together with a full exploitation of the structure of the discrete time derivative, we are able to efficiently solve problems with a tremendous number of degrees of freedom while maintaining a low storage demand in the solution process. Such a scheme can be easily adapted to solve different time-dependent PDEs and several numerical results are reported to illustrate the potential of our novel approach.

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