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Multigrid approaches for parallel-in-time integration

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Multigrid and related multilevel methods are the approaches of choice for solving the linear systems that result from the discretisation of a wide class of PDEs. One feasible approach for doing effective parallel-in-time integration is also through some kind of multilevel method. Multigrid algorithms for parabolic problems that allow temporal parallelism either employ a semicoarsening strategy or an adaptive parameter-dependent coarsening strategy. As shown in [Vandewalle and Van de Velde, Space-time concurrent multigrid waveform relaxation, Ann. Numer. Math., 1 (1994), pp. 347-360], the multigrid waveform relaxation method which uses coarsening only in the spatial dimension also permits time parallelism. The other semicoarsening approach, i.e., coarsening only in the time dimension is the basis of the multigrid-reduction-in-time (MGRIT) algorithm [Falgout et. al., SIAM J. Sci. Comput., 36 (2014), pp. C635-C661]. In space-time multigrid as presented in [Horton and Vandewalle, A space-time multigrid method for parabolic PDEs, SIAM J. Sci. Comput., 16 (1995), pp. 848-864], where time is simply another dimension in the grid, either semicoarsening in space or in time depending on the anisotropy of the discretisation stencil at each grid level is employed.

In this talk, we compare different approaches for integrating multigrid concepts into time-evolution algorithms.