
Ben O'Neill
**Multigrid Reduction in Time for Nonlinear Parabolic
Equations**

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The need for parallelism in time is being driven by changes in computer architectures, where future speed-ups will be available through greater concurrency, not faster clock speeds. This leads to a bottleneck for sequential time marching schemes because they lack parallelism in the time dimension. Multigrid Reduction in Time (MGRIT) is an iterative procedure that allows for temporal parallelism by utilizing multigrid reduction techniques and a multilevel hierarchy of coarse time grids. The goal of this work is the efficient solution of nonlinear problems with MGRIT, where efficiency is defined as achieving similar performance when compared to an equivalent linear problem. When solving a linear problem, using implicit methods and optimal spatial solvers, e.g. classical multigrid, the spatial multigrid convergence rate is fixed across temporal levels, despite a large variation in time step sizes. This is not the case for nonlinear problems, where the work required increases dramatically on coarser time grids. By using a variety of strategies, most importantly, spatial coarsening and an alternate initial guess for the nonlinear solver, we reduce the work per time step evaluation over all temporal levels to a range similar to those of a corresponding linear problem. This allows for overall speedups comparable with those achieved, in previous work, for linear systems.