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Coupled Parareal-Optimized Schwarz Waveform relaxation method for advection reaction diffusion equation

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Parareal method is a numerical method to solve time - evolutional problems in parallel, which uses two propagators: the coarse - fast and inaccurate - and the fine - slow but more accurate. Instead of running the fine propagator on the whole time interval, we divide the time space into small time intervals, where we can run the fine propagator in parallel to obtain the desired solution, with the help of the coarse propagator and through parareal steps. Furthermore, each local subproblem can be solved by an iterative method, and instead of doing this local iterative method until convergence, one may perform only a few iterations of it, during parareal iterations. Propagators then become much cheaper but sharply lose their accuracy, and we hope that the convergence will be achieved across parareal iterations.

In this talk, we propose to couple Parareal with a well-known iterative method - Optimized Schwarz Waveform Relaxation (OSWR) - with only few OSWR iterations in the fine propagator and with a simple coarse propagator deduced from Backward Euler method. We present the analysis of this coupled method for 1-dimensional advection reaction diffusion equation, for this case the convergence is almost linear. We also give some numerical illustrations for 1D and 2D equations, which shows that the convergence is much faster in practice.

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