

# Similarities and differences between Parareal, PFASST and Time Multigrid

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## Abstract

Over the last decades, many research efforts have studied iterative Parallel-in-Time (PinT) algorithms, in particular Parareal (Lions, Maday, Turinici), PFASST (Minion and Emmett), MGRIT (Falgout, Friedhoff, Kolev, MacLachlan, Schroder) and a specific form of Space-Time Multigrid (Gander and Neumueller). While various convergence analyses exist for each algorithm separately, it is difficult to connect them and compare convergence of these iterative PinT methods when applied to various model problems, and in applications.

In this talk, we use a new approach that lets us analyze the convergence of these four iterative algorithms in a single framework. Following an idea of Gander and Hairer already used to analyze Parareal convergence, this framework is based on an abstract view of each iterative PinT algorithm and provides understanding of their different convergence mechanisms. We use it to show some key similarities and differences between all those iterative methods while focusing on the Dahlquist equation, the fundamental time-dependent test problem. Furthermore, we present the gfm open source code (<https://github.com/Parallel-in-Time/gfm>), a small Python library developed for this analysis, which provides error bounds for the aforementioned methods and allows us to compare them.