Implicit Peer Triplets in ODE Constrained Optimal Control

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Recently, we have developed and analyzed implicit two-step Peer triplets for nonlinear ODE constrained optimal control problems [Journal of Computational and Applied Mathematics 416:114596, 2022, Algorithms 15:310, 2022]. We combine some standard Peer methods for inner grid points with carefully designed starting and end methods to achieve order four for the state variables and order three for the adjoint variables in a first-discretize-then-optimize approach. The notion triplets emphasizes that these three different Peer methods have to satisfy additional matching conditions. These methods do not suffer from order reduction – a phenomenon that is usually observed for one-step methods as e.g. symplectic Runge-Kutta methods. Peer methods compute several stages of equal (global) order per time step. They exhibit good stability properties, making them very attractive for stiff problems [Applied Numerical Mathematics 53:457-470, 2005]. In this talk, we will present novel implicit two-step Peer triplets, which can be applied together with a projected gradient method [`https://arxiv.org/abs/2303.18180v2`]. The key observation is that such methods have to satisfy further positivity and consistency conditions. We will also discuss the use of variable stepsizes together with the property of super-convergence [`https://arxiv.org/abs/2404.13716`]. Several numerical examples will be presented.

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