Implicit Runge-Kutta schemes for optimal control problems with evolution equations

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In this presentation we discuss the use of implicit Runge-Kutta schemes for the time discretization of optimal control problems with evolution equations. The specialty of the considered discretizations is that the discretizations schemes for the state and adjoint state are chosen such that discretization and optimization commute. It is well known that for Runge-Kutta schemes with this property additional order conditions are necessary. We give sufficient conditions for which class of schemes these additional order condition are automatically fulfilled. The focus is especially on implicit Runge-Kutta schemes of Gauss, Radau IA, Radau IIA, Lobatto IIIA, Lobatto IIIB and Lobatto IIIC collocation type up to order six. Furthermore we also use a SDIRK (singly diagonally implicit Runge-Kutta) method to demonstrate, that for general implicit Runge-Kutta methods the additional order conditions are not automatically fulfilled.

Numerical examples illustrate the predicted convergence rates.

The talk is based on the preprint [1].

References:

[1] https://arxiv.org/abs/1311.0640

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