Higher order variational integrators in the optimal control of mechanical systems

Sina Ober-Blöbaum
Freie Universität Berlin, University of Paderborn (on leave), Germany
sinaob@math.upb.de

In recent years, much effort in designing numerical methods for the simulation and optimization has been put into schemes which are structure preserving. One particular class are variational integrators which are momentum preserving and symplectic. In this talk, we develop a convergence theory on high order variational integrators applied to finite-dimensional optimal control problems posed with mechanical systems.

In the first part of the talk, we derive two different kinds of high order variational integrators based on different dimensions of the underlying approximation space. While the first well-known integrator is equivalent to a symplectic partitioned Runge-Kutta method, the second integrator, denoted as symplectic Galerkin integrator, yields a method which in general, cannot be written as a standard symplectic Runge-Kutta scheme.

In the second part of the talk, we use these integrators for the discretization of optimal control problems. By analyzing the adjoint systems of the optimal control problem and its discretized counterpart, we prove that for these particular integrators dualization and discretization commute. This property guarantees that the convergence rates are preserved for the adjoint system which is also referred to as the Covector Mapping Principle.

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