Optimal Control of Hybrid Systems via Measure Relaxations

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We propose an approach to trajectory optimization for piecewise polynomial systems based on the recently proposed graphs of convex sets framework. We instantiate the framework with a convex relaxation of optimal control based on occupation measures, resulting in a convex optimization problem resembling the discrete shortest-paths linear program that can be solved efficiently to global optimality. While this approach inherits the limitations of semidefinite programming, scalability to large numbers of discrete modes improves compared to the NP-hard mixed-integer formulation. We use this to plan trajectories under temporal logic specifications, comparing the computed cost lower bound to a nonconvex optimization approach with fixed mode sequence. In our numerical experiments, we find that this bound is typically in the vicinity of the nonconvex solution, while the runtime speedup is significant compared to the often intractable mixed-integer formulation. Our implementation is available at https://github.com/ebuehrle/hpoc.