Application of the Sequential Quadratic Programming Method to Finding Error Trajectories of Hybrid Dynamical Systems

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A hybrid dynamical system is a dynamical system that features both continuous and discrete state and behaviour. For example, a thermostat controlling the temperature in a room can be modeled as a hybrid dynamical system: When the thermostat is switched on, the temperature rises, and when it is switched off, the temperature decreases. States *off* and *on* are discrete, and the temperature in the room is a continuous state of the system.

We are concerned with the problem of finding a trajectory of a given hybrid dynamical system that originates in a given set of initial states and reaches a given set of unsafe states. We call such a trajectory from an initial to an unsafe state an *error trajectory*. One may view this problem as a variation of the classical boundary value problem. However, unlike the classical boundary value problem, in this case we search for error trajectories of *arbitrary length*.

We reformulate our problem as a continuous optimization problem and use the *Sequential Quadratic Programming* (SQP) method for finding error trajectories. We consider several different variants of the formulation, compare their numerical behaviour on a set of problems, and investigate advantages and disadvantages of each formulation. We present numerical results, and discuss sparsity of the resulting Hessian.

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