Techniques for reachability by sampling

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This presentation considers the reachability problem for dynamical systems with continuous trajectories in time and space. The goal is to characterize the set of states that a system can reach when starting from a set of initial states. In the "safety" case, where the system must avoid a given "bad" set, an over-estimation of the reachable set is sufficient. Even this approximation problem is difficult in general and most existing approaches try to compute over-estimations based on sets that are easy to manipulate.

In the present work, we want to sample the reachable set with a given accuracy, i.e. to find a finite set of points which suitably cover the reachable set and whose pairwise distances are bounded by a given value. To this end, we compute bunches of trajectories and measure their relative distances thanks to results from sensitivity analysis. Several motivations justify this approach. First, it is close to very natural test methods. In addition, its complexity mainly depends on the size of the initial set; the dimension of the state space has little influence. Finally, the sampling of reachable sets can be used in the framework of reinforcement learning to generate clever trial trajectories used to compute the optimal value function.