The Center for Control, Dynamical Systems, and Computation
University of California at Santa Barbara
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Presents

Homothety and Invariance in Approximate Reachability and Robust Control Synthesis for Linear Discrete Time Systems

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Abstract:

The talk discusses the utilization of set invariance and homothety in reachability analysis and ro-bust control synthesis for linear discrete time systems. In the first part of the talk we re-examine briefly the minimality and maximality of invariant sets for linear discrete time systems subject to bounded, additive, uncertainty by utilizing the recent theoretical framework reported by Artstein and Rakovic. Utilizing set–dynamics induced by the uncertainty set and the underlying dynamics in the state space we derive an adequate modification of the standard reachability and viability algorithms and, in turn, obtain a computationally tractable method for the calculation of the outer invariant approximations of the minimal invariant set as well as the inner invariant approximations of the maximal invariant set. The offered procedures for the computations of invariant approximations of the minimal and maxi-mal invariant set are dual to each other. The procedures produce sequences of improving invariant approximations of the minimal and the maximal invariant set, that are, under adequate conditions, monotonic set sequences and converge, respectively to the minimal and the maximal invariant set. We also provide an explicit formula for estimates of the Hausdorff distance between the underlying set iterates and the minimal and the maximal invariant sets.

In the second part of the talk we discuss a method for approximate reachability, for linear discrete time systems, based on homothety and set invariance. The proposed method utilizes two particular families of sets, more precisely their members, and particular forms of the approximation maps to ob-tain simple inner and outer approximate reachable sets/tubes. The resulting set–dynamics, induced by the uncertainty set, the underlying dynamics in the state space and the approximation maps, are restricted to these particular families of sets and under standard assumptions yield bounded and convergent approximate reachable sets/tubes. The proposed method is computationally (relatively) simple and does not suffer from the so–called “wrapping effect” but in contrary provides improving inner and outer estimates of the exact reachable sets. We also discuss an exceptional case when the Hausdorff distance between the inner and outer approximate reachable sets converges to zero in the limit.

About the Speaker:

Sasa V. Rakovic received the B.Sc. degree in Electrical Engineering from the Technical Faculty Cacak, University of Kragujevac, Serbia, and the M.Sc. degree in Control Engineering and PhD degree in Control Theory from Imperial College, London. From 2004 to November 2006, he held the post of a research associate in the Control and Power Research Group at Imperial College London. He is currently with the Automatic Control Laboratory, IFA, ETHZ. His main research interests are set invariance, reachability and control synthesis under uncertainty.