Graduate Student Research Seminar

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Reachability Analysis Using Spectrum of Koopman Operator

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Reachability analysis is a powerful tool for the safety and stability problem of complex nonlinear systems. Existing methods such as set-based approaches provide accurate solutions for linear systems. Hamilton-Jacobi-based approaches used for controlled nonlinear systems require a solution of the partial differential equation and suffer from scalability. Therefore, to overcome these challenges it is important to develop an algorithm to compute the reachable set for a complex nonlinear dynamical system. This work proposes the Koopman operator-based approach for the reachability analysis of an autonomous dynamical system. In particular, we demonstrate the application of spectral analysis of the Koopman operator involving eigenfunctions and eigenvalues in the approximate computation of forward and backward-reachable sets for an autonomous dynamical system. The formal guarantees for the approximate reachable sets are provided using the Hausdorff distance between sets that measure how far the approximate reachable set is from the true reachable set. A computational framework based on convex optimization is provided to compute the Koopman spectrum and the approximate reachable set. Finally, we present simulation results to demonstrate the application of the developed framework.

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