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DATA INSPIRE: Morse Graphs can effectively estimate the Regions of Attraction (RoAs) of dynamical systems, including closed-box ones.

Thursday 27 October 2022 10:10 (1 hour)

This work proposes an integration of surrogate modeling and topology to significantly reduce the amount of data required to describe the underlying global dynamics of robot controllers, including closed-box ones. A Gaussian Process (GP), trained with randomized short trajectories over the state-space, acts as a surrogate model for the underlying dynamical system. Then, a combinatorial representation is built and used to describe the dynamics in the form of a directed acyclic graph, known as *Morse graph*. The Morse graph is able to describe the system's attractors and their corresponding regions of attraction (RoA). Furthermore, a pointwise confidence level of the global dynamics estimation over the entire state space is provided. In contrast to alternatives, the framework does not require estimation of Lyapunov functions, alleviating the need for high prediction accuracy of the GP. The framework is suitable for data-driven controllers that do not expose an analytical model as long as Lipschitz-continuity is satisfied. The method is compared against established analytical and recent machine learning alternatives for estimating \roa s, outperforming them in data efficiency without sacrificing accuracy. Link to code: \url{https://go.rutgers.edu/49hy35en}

Research

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