Robotics and Autonomous Systems Thesis Defense

Data-Driven Abstraction and Model Discrimination Techniques with Applications to Intent Estimation of Autonomous Systems

School for Engineering of Matter, Transport and Energy

Mohit Mukul Bhagwat
Advisor: Sze Zheng Yong

Abstract

In this work, we consider the problem of designing an algorithm to approximate the dynamics of the unknown non-linear system using just the raw experimental data that is available, then devise ways to discriminate two or more of the learnt models using certain model discrimination techniques. This kind of model discrimination techniques finds one of its application in intention estimation of the system models under consideration, where one certain ""normal"" model of the system is learnt, and all the other corresponding models are invalidated against the earlier learnt model. The proposed steps to reach the end goal of the algorithm for intention estimation involves two steps: First, using the experimental data that is available for the system, we use optimization-based techniques to over-approximate the dynamics of the system by constructing an upper and lower function which encapsulates/ engulfs the data points in all the dimensions that are considered. This over-approximation is a conservative preservation of the dynamics of the system, this way we can ensure that any model which is invalidated against this approximation is assumed to be invalidated with the actual model of the system. The next step involves the use of optimization techniques to compare two different approximated models of the system using the algorithm for 'T-Detectability' and 'Model Invalidation', which gives us a finite horizon time 'T', within which the pair of models are guaranteed to be distinguished. Due the large amount of data under consideration certain computational aware improvements were done on the processing of the data and algorithms developed. The effectiveness of the above-mentioned algorithms are applied to two examples. The first is the data collected from the simulation of a swarm of agents, moving in a defined pattern, these swarms are also known as 'Boids'. The second example, is the vehicle intention estimation using the 'HighD' dataset of naturalistic trajectories of vehicles recorded on German Highways.

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Zoom Link: https://asu.zoom.us/j/82091647041