DECENTRALIZED ABSTRACTIONS FOR MULTI-AGENT SYSTEMS UNDER COUPLED CONSTRAINTS

Abstract

Task planning for multi-agent systems under high level specifications constitutes an active area of research which lies in the interface between computer science and modern control theory. A challenge in this new interdisciplinary direction constitutes of the problem of specifying abstractions for continuous time multi-agent systems, namely, networks of coupled dynamic units that are called agents. The term abstraction refers to a discrete state transition system that preserves some properties of interest of the original system while ignoring detail, providing thus a framework which is suitable for the analysis and control of large scale systems and the synthesis of high level plans.

In this talk we focus on multi-agent systems whose motion is described by the single integrator model. The dynamics of each agent in the network consist of feedback interconnection terms, which ensure that certain system properties as for instance network connectivity and forward invariance of the system's solution are preserved, and additional bounded input terms, which we call free inputs and provide motion planning capabilities under the coupled constraints. The construction of a discrete state transition system relies on the selection of a cell decomposition, namely, a partition of the agents' common workspace which can be identified with each agent's individual state space, and a time discretization step δt. Our goal is to construct for each agent its individual transition system, whose discrete state set is specified through the possible cells that the agent and its neighbors belong. Given an initial cell configuration of the agent and its neighbors, the transition system captures the capability of the agent to select for each continuous state in its initial cell a free input, in order to reach a final cell at time δt, for all possible continuous initial states of its neighbors in their corresponding cells and selection of their free inputs. High level planning requires the transition system to be well posed-meaningful, which implies that for each initial cell it is possible to transit to (at least) one final cell.

In the first part of the talk, the definition of a well posed abstraction is provided, and sufficient conditions on the space and time discretization are derived, which ensure that it is possible to extract a meaningful transition system. The abstraction framework is based on the design of hybrid feedback control laws which are assigned to the free inputs and guarantee the implementation of the discrete transitions by the continuous time system. Then, the framework is extended in order to ensure multiple discrete transitions which provide the possibility for motion planning, i.e., to specify different possibilities for transitions for each agent by modifying its controller.