MAXIMUM ENTROPY SYSTEM MODELS AND ROBUST FEEDBACK CONTROL

John S. Baras
Institute for Systems Research,
Electrical and Computer Engineering Department, and
Computer Science Department
University of Maryland College Park

ABSTRACT

We consider the problem of output feedback control of partially observed automata (finite state machines) when uncertainties in the model or observations are present. The problem is to design a feedback controller that is robust to both structural and parametric uncertainties. We develop a framework that unifies the deterministic and stochastic approaches to this problem. The framework introduces the concept of 'costs' for parasitic transitions caused by these model uncertainties. First a deterministic model for uncertainties is introduced, leading to a dynamic game formulation of the robust feedback control problem. This problem is solved using an appropriate information state. We then derive a Hidden Markov Model for the given partially observed automaton and its uncertainties, as the maximum entropy stochastic model for the automaton. A risk-sensitive stochastic control problem is formulated and solved for this Hidden Markov Model. Thus for the first time we are able to explain previous results on the randomization of the deterministic game and the associated risk-sensitive stochastic control problem via the Lagrange multipliers introduced in the maximum entropy model construction. These concepts unify the two basic approaches to robustness for output feedback control and furthermore via duality introduce interesting sensitivity computations regarding information, complexity and control. The two approaches are then also linked using small noise limits and large deviations methods. Some applications illustrate the significance of the results and of the associated computations.