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.