Human Decision-Making and Multi-Armed Bandit Problems

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Tuesday, September 20, 4:00 pm | 205 Thurston Hall
Refreshments at 3:30 p.m. | 204 Thurston Hall

ABSTRACT

Human decision-making in explore–exploit tasks, from resource allocation to search in an uncertain environment, can be modeled using multi-armed bandit problems, where the decision maker must choose among multiple options with uncertain rewards. Rigorous examination of the heuristics that humans use in these tasks can help in designing and evaluating strategies for performance in a wide range of real-world decision-making scenarios that involve humans, machines or both. In the standard setting, the objective is to optimize accumulated reward over a sequence of choices, which creates a tension between choosing the most rewarding among known options (exploitation) and choosing poorly known but potentially more rewarding options (exploration). I will discuss results from multi-armed bandit experiments with human participants and features of human decision-making captured by a model that relies on Bayesian inference, confidence bounds, and Boltzmann action selection. I will discuss extensions to distributed cooperative decision-making in multi-player multi-armed bandit problems and to satisficing objectives.

BIOGRAPHICAL SKETCH

Naomi Ehrich Leonard is the Edwin S. Wilsey Professor of Mechanical and Aerospace Engineering, Director of Princeton’s Council on Science and Technology, and Associated Faculty in Applied and Computational Mathematics at Princeton University. She is a MacArthur Fellow, a member of the American Academy of Arts and Sciences, and a Fellow of the IEEE, ASME, SIAM, and IFAC. Leonard received the B.S.E. degree in Mechanical Engineering from Princeton University in 1985 and the M.S. and Ph.D. degrees in Electrical Engineering from the University of Maryland in 1991 and 1994. Her research and teaching are in control and dynamical systems, where she has made contributions to both theory and application. Her current interests include coordinated control of multi-agent systems, mobile sensor networks, collective animal behavior, and human decision dynamics.

Leonard has recently focused on developing rigorous means to show how features of agent interconnections, such as network structure, heterogeneity of information, and leadership, determine collective dynamics and performance as measured by speed, accuracy, robustness, and flexibility in a changing environment. She has collaborated with biologists to study the mechanisms that explain the inspiring collective dynamics of animal groups, including killifish, honeybees, caribou, and starlings, as well as to explain human decision-making under uncertainty. Capitalizing on her findings, she has developed models and rigorous methodology for design of distributed control of multi-agent systems with guaranteed performance. Leonard led a large, multidisciplinary project that culminated in a major field demonstration in Monterey Bay, CA of a first-of-its-kind automated and adaptive ocean observing system. The system comprised a coordinated network of underwater robotic gliders that moved about on their own for weeks at a time collecting scientific data about the ocean. Leonard also engages in work at the intersection of dance and collective dynamics.