Foundations of Decision Making with Behavioral and Computational Constraints

Abstract

We propose a bold new interdisciplinary research program to create a rigorous foundation for individual and group decision-making under computational and cognitive constraints. The standard model of rational decision-making maintains that individuals use Bayes’ rule to incorporate new information into their beliefs. In addition to its normative appeal, this Bayesian paradigm serves as a highly useful benchmark by providing a well-grounded model. Despite these advantages, a growing body of evidence has scrutinized this framework on the basis of its unrealistic cognitive demand on individuals, especially when they make inferences in complex environments consisting of a large number of other decision-makers. To address these issues, researchers have adopted an alternative paradigm by assuming non-Bayesian behavior of agents. Over the past two decades, the fields of behavioral economics and behavioral decision theory have sought to explain observed deviations from the predictions of rational decision making of individuals and groups. Despite some success in such efforts, the modeling approaches that result are typically ad hoc and fail to articulate what deviations from Bayesian rationality actually lead to the observed non-Bayesian behavior in the agents. Consequently, we still lack a unified theory on human decision-making.

Creating a foundational theory of behavioral and rational decision-making that addresses the above-mentioned shortcomings is of paramount importance to DoD in general, and the Army in particular. Various vision documents for the Army of the future (2040 and beyond) have emphasized the importance of strategic command of information and decision-making in networks where individual agents have information of varying quality and precision, information exchange is limited and localized; decision making is purely local; and the sources, reliability, and trustworthiness of information is unclear. There is also an overabundance of battlefield data which is often incomplete, error laden, and must be processed to give unambiguous tracks and target state vectors and to provide actionable information to the warfighter. Existing theories of decision-making and rational inference discussed earlier are wholly inadequate for dealing with these scenarios.

Our proposed effort is divided into three synergistic Thrusts, each composed of multiple interrelated tasks. In the first Thrust, we will develop a new foundation for individual decision making under computational and cognitive constraints and develop hierarchy of models that rationalize different cognitive biases. In the second Thrust, we will develop a unified framework for the study of rational and behavioral decision making in groups. Our third Thrust is devoted to data-driven modelling of biases as well as behavioral online experiments.

Our team of 6 PIs consists of distinguished experts in a wide range of areas, from network science to computational social science and algorithms, decision theory, game theory, cognitive science, and collective behavior. All PIs have a track record in interdisciplinary research on the core topics of the proposal with a strong history of collaboration on previous and existing DoD efforts. Our distinguished team of PIs consists of laureates of MacArthur, Gödel Prize, and Vannevar Bush Fellowships.