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Cognitive Decision Theory: Developing Models of Real-World Decision Behavior

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For 300 years, the areas of economics, statistics, and probability theory, have held the decision sciences captive with the likes of Bernoulli, Laplace, Von Neumann, Savage and others, developing normative or rational models of decision making. A weakness of this approach, however, is that it disregards the cognitive capabilities of the agent and only considers the environment in which behavior takes place. In contrast, cognitive scientists have often failed to recognize that the processes they're trying to model take place in an uncertain world involving serious consequences. Thus, cognition in the real world needs to confront decision-making topics.

In this symposium, we survey several recent examples of the emerging field we call Cognitive Decision Theory – a branch of decision theory in which models of judgment and decision making are built from principles of cognition rather than axioms of rationality. As the talks in the symposium illustrate, the application of cognitive models to understanding judgment and decision making addresses the weaknesses of both cognitive and decision science. On the one hand, models of decision making become more plausible with the realization that the cognitive system places constraints on the types of processes (or heuristics) that are assumed to guide actual decision behavior. On the other hand, models of cognition are challenged to re-conceptualize how their laboratory-derivations can be scaled up to account for cognition in the real world.

Diagnostic Hypothesis Generation & Human Judgment

Michael Dougherty* & Rick Thomas

Inductive inference is a fundamental component of everyday reasoning, both by lay people and by professionals. Indeed, hypothesis generation processes occur in any task that involves taking “data” and formulating possible explanations of that data, including clinicians’ generation of diagnoses on the basis of symptoms (e.g., Botti & Reeve, 2003), auditors’ diagnosis of sources of accounting errors

(Libby, 1985), and mechanics’ diagnoses of auto failure on the basis of symptoms (Mehle, 1982). In all of these cases, the generation of diagnostic hypotheses serves as the lynchpin for inductive inference, for evaluating the likelihood of various hypotheses, and for searching for information in the environment to test hypotheses. Although a great deal is known about how people assess the probability of particular hypotheses and how they search for information to test hypotheses, much less is known about the role of hypothesis generation in these processes. In this talk, I will present an overview of a new cognitive theory of inductive inference, HyGene (Thomas, Dougherty, Sprenger, & Harbison, 2007), and illustrate the implications of hypothesis generation both for understanding judgment, and for understanding basic memory processes.

The Adaptive Decision Maker: Selecting Strategies According to the Environment

Jörg Rieskamp

How do people make probabilistic inferences, such as inferring which of two patients needs more urgent treatment? Bayesian models have been proposed as normative benchmarks for such tasks. However, it has been demonstrated that for many real-world inference tasks, simple heuristics can perform astonishingly well and sometimes even outperform Bayesian models. If people behave adaptively, it can be predicted that they will select simple heuristics in environments where the heuristics outperform cognitively more demanding strategies. To describe the adaptive process of strategy selection, a computational model will be proposed that specifies how people select strategies. The strategy selection learning theory predicts a strategy selection process on the basis of reinforcement learning. The theory was supported in several experimental studies and makes better predictions than alternative accounts.

Bayesian Models of Human Inference

Josh Tenenbaum

Bayesian inference is becoming increasingly popular as the basis for computational models of many aspects of human cognition, including visual perception, motor control, language acquisition and processing, causal reasoning, categorization, and predicting everyday events. I will reconcile these new developments with classic research in judgment and decision-making, often interpreted as showing that "people are not Bayesian". While the mind is not likely to be a general-purpose Bayesian computer, I will argue that many problems of inductive inference which are important for human minds to solve in natural contexts -- problems that we solve by and large successfully, effortlessly and unconsciously -- can be distinctively illuminated and explained via Bayesian analyses once we correctly understand the real-world structure of these problems.

A Computational Model of the Attention Processes Used to Generate Decision Weights in Risky Decision Making

Joseph G. Johnson & Jerome Busemeyer*

During the past 50 years, a number of paradoxes have led to the downfall of expected utility theory as a viable description of decision making. Recently, rank-dependent theories (e.g. cumulative prospect theory) have arisen as the "leading" descriptive approach. A key component of these theories is the decision weight that reflects the importance of consequences when evaluating an action. Although functional forms of decision weights exist, little is known about the source of these weights. We present a cognitive processing mechanism for decision weights that is derived from a stochastic model of decision making called decision field theory. According to decision field theory, decisions are based on a sequential sampling process: Preferences for each action accumulate across time until one of them reaches a threshold, and the first to reach the threshold is chosen. The preference for each action is updated by evaluations generated from momentary shifts in attention across the possible outcomes associated with each course of action. Using this attention switching mechanism, we show how decision field theory produces weights similar to those captured by several common weighting functions. Furthermore, this attention switching mechanism provides a coherent explanation for several robust phenomena including some that cannot be explained by rank dependent utility theories.

Using Cognitive Models to Better Understand & Identify Real World Risk Takers

Timothy J. Pleskac*, Thomas S. Wallsten, & Carl Lejuez

Risk-taking behavior can occur both in a psychologist's laboratory and in real-world situations. Recently, risk seeking during a complex laboratory-based gambling task -- the Balloon Analogue Risk Task (BART; Lejuez et al., 2002) -- has been found to be correlated with risk seeking in life (e.g., abuse drugs, smoke, drive without a seatbelt). However, because multiple cognitive processes contribute to risk seeking behavior, it is difficult if not impossible to arrive at a process-pure understanding of how and why this relationship exists. During this talk we describe a cognitive model that distills BART performance into three cognitive components: Bayesian learning, reward evaluation, and response selection. We then demonstrate the strengths of the model with theoretically-driven modifications to the BART that better isolate the cognitive processes responsible for its association to real-world risky behavior. This approach of modeling complex laboratory tasks with high predictive validity challenges the cognitive modeler to incorporate multiple processes and their interrelation into one common model. At the same time, the cognitive model brings a better understanding to the latent cognitive factors underlying risky behavior in the real world.

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