Integrating human and robot decision-making dynamics*

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The superior ability of humans to recognize pattern and extract structure from data makes human decision-making invaluable to performance of complex tasks in uncertain, changing environments. On the other hand, there is tremendous advantage to automating cooperative tasks with multi-agent robotic systems as has been witnessed, for example, in the growing success of mobile sensor networks. Of great interest is to investigate how humans and robots can best *jointly* contribute to decision-making. Psychologists and behavioral scientists perform experiments with human subjects and develop models to study human decision-making; for example, there is an ample literature on a class of sequential binary decision-making called the two-alternative forced-choice task [1, 2, 3]. In this task, the human subject chooses between two options at regular time intervals and receives a reward after each choice. Interestingly, these experiments show convergence of the aggregate behavior to rewards that are often suboptimal.

We introduce a decision-making problem associated with a complex task that integrates human and robotic decision-making dynamics with feedback. The setting is a human-supervised collective robotic foraging problem, where the human decision-making takes the form of a two-alternative forced-choice task and the reward report is a feedback from the robots. This allows direct use of the results from psychology to study how the human will behave.

To explore the integrated decision dynamics, we present two models of human decision-making: one is the win-stay, lose-switch model and the other is a deterministic limit of the popular drift diffusion model. With these models we prove convergence of the human behavior to the observed aggregate decision-making for reward structures with matching points. Since behavior converges to suboptimal performance, we show how adaptive laws for the robot feedback that use only local information can be applied to help the human make optimal decisions.

This is joint work with Ming Cao and Andrew Stewart.

References

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