

Summary: Bayesian decision theory in sensorimotor control

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1 Important resources

Link to the paper: [https://www.sciencedirect.com/science/article/pii/S1364661306001276!](https://www.sciencedirect.com/science/article/pii/S1364661306001276)
[Unfortunately not Open Access]

2 Domain-specific prerequisites

- General notions on Probability Theory
- General notions on Bayesian statistics (the paper provides a basic introduction)

3 Paper Notes

What

Action selection in sensorimotor control is a decision process that depends on the state of our body and the environment. The authors review recent studies that formalize human decision making as being based on partial uncertainty and utility functions.

Why

Direct quotation: "There is convergence evidence from various communities that Bayesian approaches can serve as coherent description of human decision making".

How

Bayesian integration

The first study tests whether people combine prior knowledge of the statistic of a task with the likelihood obtained from the sensory input to estimate optimally a variable (e.g. bouncing location of a tennis ball). The study confirms that the prediction of an optimal Bayesian system is very close to the one exhibited by the participants of the study. Thus, it is reasonable to assume that people use an optimal Bayesian strategy to locate the tennis ball.

A second category of studies addresses how human perception can be described by Bayesian

estimation processes. Brightness perception, shape perception, movement perception and certain illusions have been shown to arise as optimal percepts in Bayesian models.

A third category of studies analyzes how humans combine different perceptions (e.g visual perception and tactile perception). They confirm that the combination of these joint distributions can be framed using Bayesian statistics.

Costs and rewards

To use a rational framework it is important to understand which costs and rewards the decision maker is optimizing. An example of cost is the energy consumed during a movement. Other possible cost functions the various researchers proposed are the smoothness or the precision of the movement.

The utility function can be calculated by producing forces of varying magnitudes and duration and letting human participants choose which movement to perform.

4 Interesting references

- Russell, S. and Wefald, E. (1991) Principles of metareasoning. *Artif. Intell.* 49, 400–411
- Körding, K.P. and Wolpert, D.M. (2004) Bayesian integration in sensorimotor learning. *Nature* 427, 244–247

5 Personal comments

As the authors claim, there is evidence that bayesian statistics describe the human decision making process. It would be interesting to explore this concept beyond the realm of sensorimotor control.