A Neuronal Theory of the Decision Process

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Abstract

We develop a biologically realistic theory of the decision process, and compare its predictions to existing data on choice and single neuron recording in monkeys. Biologically realistic means that there are no ``as if'' components in the model. The model identifies a network of neurons of three types, each type with a distinct role in the process, and shows how their interaction produces choice. The model also predicts the pattern of firing rate of each type of neuron during the trial, and how it depends on the options offered.

The theory provides the neural foundation for a solution of three classical problems in decision theory: stochastic choice, reference point, existence of a cardinal utility. The model describes how stochastic choice is implemented by the network, and how the technology of the network imposes constraints on the error rate. Since neurons adapt their response to the distribution of offers in the environment, the choice made depends in a systematic way on this distribution and not just on the currently available options. We show how within the constraints imposed by the network such adaptive coding is optimal. Finally, no single group in the network codes cardinal utility before the choice; instead a cardinal utility is expressed after choice.

The predictions of the model are tested against data on firing rates and choice. The test provides strong support for the theory.