



Economic Behaviors Emerge from Local Learning Rules under Fast Environmental Feedback

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Repeatedly choosing well between options is vital for animal survival. Researchers have categorized such decisions in three broad paradigms: (1) cued decision-making, guided by sensory cues about rewards; (2) foraging, based on experience with a resource's value; and (3) strategic games, where choices depend on competitor behavior. Prior work has produced an abundance of models for this behavior, e.g. drift diffusion models [1,2], evidence accumulation [2], marginal value theorem [3,4], bistable attractors [5,6]. But these efforts typically focus on a single behavior at a time, which limits cross-task generalization.

To fill this gap, we present a biologically plausible model that combines prior work from Li et al. [7], Pereira-Obilinovic et al. [8], and Loewenstein & Seung [9] into one unified algorithm: a noisy neural network that uses only local synaptic learning rules and acts in continuous, closed-loop interaction with a task environment.

The model can explain behaviors across all three behavioral paradigms in two-alternative forced choice (2AFC) tasks: cued choice 2AFC; two-armed bandit tasks (foraging); and matching pennies, a zero-sum game where players win if their choices match a computer opponent's [10]. Through tight environmental feedback loops, models replicate key behavioral features that have previously required distinct models to achieve: (1) random walk dynamics in cued-choice tasks [11], (2) probability matching in two-armed bandit tasks [12-14], (3) learning to be stochastic in matching pennies [10], and (4) autonomous transitions between distinct behavioral states in all tasks.

Overall, this work contributes toward a more integrated view of behavior, showing that a diverse set of economic decision-making behaviors can be performed not by a patchwork of specialized algorithms, but by one flexible mechanistic model shaped by environmental demands.

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