Memory, Temperature and Instability in Games

J. Burridge[1], Y. Gao[2], Y. Mao[2]

(1) Mathematics Department, University of Portsmouth, U.K.
(2) School of Physics and Astronomy, University of Nottingham, U.K.

We investigate the dynamics of games where agents have a finite memory of the past, used to infer the currently optimal strategy. This inference is then used either to update their current mixed strategy, or transfer to a new pure strategy. A longer memory is an advantage when the system is in stable equilibrium, because it provides more accurate samples of the behaviour of opponents. However, excessive memory can destabilize the system, leading to the formation of a limit cycle via a Hopf Bifurcation. When this cycle emerges, short memory agents have a competitive advantage because their memory is more recent. By imposing some simple population dynamics we show that the transition point from stable equilibrium to oscillations is itself a stable fixed point of the population dynamics - the bifurcation point is a "self -organized" state. Finally we show that the temperature of decision making is cooled by memory, allowing analogy to classical thermal urn models.