Procedurally rational players through descriptive simulations

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An idea of procedurally rational players has been introduced by Osbourne & Rubinstein (1998). They define a sampling equilibrium as a steady state in a population of players using sampling procedure. Sethi (2000) introduces a model of an average behavior of a group of players using sampling procedure.

Sampling equilibrium $\pi^\star$ for a 2×2-game with strategies A and B is interpreted as an average proportion of players using strategy A and B, but defined through so called *winning probabilities* $w(\cdot, \pi)$. This definition, though based on story about some dynamics, is static what is a typical drawback of classical approach. This gap was filled with so called *sampling dynamics*, defined through the following differential equation:

$$\dot{x}(t) = w(A, \pi) - x(t)$$

where x is proportion of players using strategy A.

The above definitions of both equilibrium and dynamics give peculiar results in certain games. In particular the benchmark coordination game with one Pareto-optimal equilibrium and one risk dominant equilibrium was analyzed. For this benchmark game sampling dynamics takes the following form: $\dot{x}(t) = 0$, which is strange in context of the very sampling procedure. To investigate this phenomenon the descriptive simulation was proposed.

The descriptive simulation of a group of players using sampling procedure leads to completely new mathematical model of a sampling dynamics and sampling equilibrium. The new difference equation describing average behavior of group of players using sampling procedure reads:

$$r_A(t+1) = r_A(t) - \delta r_A(t) + \pi_\delta(S_B)N(1-\delta)w(A, \pi_\delta),$$

where r_A is number of players using strategy A while not sampling.

The new model is compared with the original model using the benchmark game with Pareto-optimal equilibrium and risk dominant equilibrium. New globally asymptotically stable equilibrium is defined and results of simulations are discussed.