Variance strikes back: sub–game-perfect Nash equilibria in time-inconsistent N-player games, and their mean-field sequel

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Abstract

We investigate a time-inconsistent, non-Markovian finite-player game in continuous time, where each player's objective functional depends non-linearly on the expected value of the state process. As a result, the classical Bellman optimality principle no longer applies. To address this, we adopt a two-layer game-theoretic framework and seek sub–game-perfect Nash equilibria both at the intra-personal level, which accounts for time inconsistency, and at the inter-personal level, which captures strategic interactions among players. We first characterise sub–game-perfect Nash equilibria and the corresponding value processes of all players through a system of coupled backward stochastic differential equations. We then analyse the mean-field counterpart and its sub–game-perfect mean-field equilibria, described by a system of McKean-Vlasov backward stochastic differential equations. Building on this representation, we finally prove the convergence of sub–game-perfect Nash equilibria and their corresponding value processes in the N-player game to their mean-field counterparts.

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