MFG without rational expectations

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Mean Field Game (MFG) models implicitly assume "rational expectations », meaning that the heterogeneous agents being modeled correctly know all relevant transition probabilities for the complex system they inhabit. When there is common noise, this assumption results in the "Master equation" (a.k.a. "Monster equation"), a Hamilton-Jacobi-Bellman equation in which the infinite-dimensional density of agents is a state variable. The rational expectations assumption and the implication that agents solve Master equations is unrealistic in many applications. We show how to instead formulate MFGs with non-rational expectations. Departing from rational expectations is particularly relevant in "MFGs with a low-dimensional coupling", i.e. MFGs in which agents' running reward function depends on the density only through low-dimensional functionals of this density. This happens, for example, in most macroeconomics MFGs in which these low- dimensional functionals have the interpretation of "equilibrium prices." In MFGs with a low-dimensional coupling, departing from rational expectations allows for completely sidestepping the Master equation. As an example, I will present results from a follow-up project that sidesteps the Master equation using a reinforcement learning approach.