An approximation of the solution to a fractional Hamilton-Jacobi-Bellman equation via reinforcement learning

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Continuous Time Random Walks (CTRWs) are used widely for modelling anomalous diffusion, which is quite a ubiquitous phenomenon in nature. Since the seminal work of N. V. Krylov [1] there has been a lot of research in the field of controlled diffusion processes, but control of CTRWs has been introduced only recently in [2] and gives rise to fractional Hamilton-Jacobi-Bellman (HJB) equations for the corresponding payoff function limits.

Here we focus on controlling the direction of CTRW jumps for successful navigation in a bounded domain, which falls into the framework studied in [2]. We apply Q-learning, more specifically, the Deep Deterministic Policy Gradient approach [3] for approximating the optimal strategy and the solution of the emerging fractional HJB equation. Wellposedness of corresponding Cauchy problem was studied earlier in [3].

Random waiting times between jumps can explain several different dynamics characteristics, one of which is that the feedback from the environment may only be available at certain instances and after the agent performing the CTRW has landed a jump it may need to wait for the environment feedback to appear. We assume that the jumps and the waiting times are i.i.d. and have stable and Pareto distributions, respectively. In our scenario the agent does not have any prior knowledge about the model for its dynamics.

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