HIGH RANK PATH DEVELOPMENT: AN APPROACH OF LEARNING THE FILTRATION OF STOCHASTIC PROCESSES

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Since the weak convergence for stochastic processes does not account for the growth of information over time which is represented by the underlying filtration, a slightly erroneous stochastic model in weak topology may cause huge loss in multi-periods decision making problems. To address such discontinuities Aldous introduced the extended weak convergence which can fully characterise all essential properties, including the filtration, of stochastic processes; however was considered to be hard to find efficient numerical implementations. In this paper we introduce a novel metric called High Rank PCF Distance (HRPCFD) for extended weak convergence based on the high rank path development method from rough path theory, which also defines the characteristic function for measure-valued processes. We then show that such HRPCFD admits many favourable analytic properties which allows us to design efficient algorithms to ensure the stability and feasibility in training. Finally, by using such metric as the discriminator in hypothesis testing and generative modeling, our numerical experiments validate the out-performance of the approach based on HRPCFD compared with several state-of-the-art methods designed from the perspective of weak convergence, and therefore demonstrate the potential applications of this approach in many classical financial and economic circumstances such as optimal stopping or utility maximisation problems, where the weak convergence fails and the extended weak convergence is needed.